VOL. XV, NO. 2 APRIL, 1933 Old Series Vol. XXXI, NO. 2

The Journal of Bone and Joint Surgery

THE BACKGROUNDS AND FOREGROUNDS OF ORTHOPAEDICS *

BY JOEL E. GOLDTHWAIT, M.D., BOSTON, MASSACHUSETTS

The choosing of a subject for such a lecture as this has not been easy but, with the background of nearly forty-five years of practice in our special branch of surgery, with the privilege of acquaintance with many of the great leaders in our work for the generation previous, together with the appreciation of the work as it is being developed today, it seemed not unreasonable to make of this meeting a time of analysis of the real features which led to our existence as a specialty, and which are shaping it for permanence or for ending.

In such an analysis, naturally that which has gone before is important in planning expectations for the future. To predict what is ahead must, of necessity, be attended with uncertainty, but, if the history of the work is carefully studied, the prediction for the future is much more likely to be correct than if it is attempted without such knowledge.

It is essential, if we are to shape our course rightly, that the foundations of our work be known and studied. Knowledge of this sort not only helps us in matters of direction of our efforts, but also saves what would otherwise be much duplication of effort.

In such a study it is natural to turn to the words of the founder of our branch of medicine. In 1741, Dr. Andry, the Councillor to the King of France, the Professor of Medicine in the Royal College, and Senior Dean of the Faculty of Physick at Paris, wrote a book entitled "Orthopaedia: Or, the Art of Correcting and Preventing Deformities in Children".† The title, as the author explains, is made up of two Greek words, meaning straight, or free from deformity, and child. The book then goes on to describe the general structure of the individual with rules for its best possible use. The text is simple, so that it "may be put in Practice by Parents themselves and all such as are employed in Educating Children".

*The Robert Jones Lecture delivered at the Hospital for Joint Diseases, New York City, October 27, 1932.

†Orthopaedia: Or, the Art of Correcting and Preventing Deformities in Children. Translated from The French of M. Andry. London, A. Millar, 1743.

The book deals with the "correction and prevention of deformities", but in the text that which has to do with prevention uses two-thirds of the book.

In this treatise the author deals first with the structure of the individual and, once this is appreciated, the function to be expected. As for the structure, the author recognizes the fact that all are not made alike, the types of the present day being plainly stated (Book I, page 71):

"The Neck is either long or short, thick or slender.

"The Breast is either broad or narrow, flat or rising.

"The Waist is either thick and clumsey, or slender and delicate; short or long. . . .

"The Legs are either slender or thick, long or short, or of a middle length. Here we must remark that when the Neck is long, the Legs and Ears are long likewise. . . .

"There is not one of those different Conformations, as well of the Head as of the other parts of the Body, that does not bear a necessary proportion to the rest of the parts."

After dealing at some length with the varying structure of the individual, similar in every way to the so called "body types" of our day, the author then goes on to the study of such structure with function as the chief aim. After describing the spine, he states (Book II, page 77): "When the Spine is straight, well set, and finely turned, it makes a handsome Body; and where it is crooked and ill turned, the body is Deformed."

Later, in describing the chest, he states (Book II, page 79): "A high Chest, for Example, provided it is not raised above a certain Point, has a fine Effect upon the Eye. A Chest, on the contrary, that is flat and depressed, looks very disagreeable; besides that this Figure is not so commodious, neither for Health nor long Life."

In order that the body may be developed at its best—and in this he constantly refers to the best for function as being the best aesthetically—he begins with "Caution to Mothers when they swaddle their Infants", so that the shoulders and chest may not be cramped or distorted.

For a later stage of child life, the "Proportion of the Haunches and Belly" is discussed. "The Haunches should be held flat; the Belly should not advance too much forward." As part of the treatment of such conditions, careful attention is given to special chairs and ways of sitting. In this he even recognized the sagging of the abdominal organs and a special chair is suggested to assist with the treatment of this condition.

In this general discussion the selection of the proper shoes receives careful consideration (Book II, page 85). "Shoes that are too high heeled will make the Bodies of Children crooked."

Careful instruction is given for children when sewing or studying that the body may be used rightly.

Also the positions in bed for sleep (Book II, page 86): "Not to let Children sleep upon high Bolsters, or to allow them none at all, is another means for preserving the Bodies of Children straight." This from a

Frenchman, to those who know the national use of the bolster, makes the elimination surprising.

The appreciation of the best that we know of "Body Mechanics" today is indicated in the following (Book II, page 89): "When a Child advances his Belly too much, some imagine the best method is to clap a bit of Lead upon it, or some other Weight; but by this means he is obliged to bend himself backwards." "She (Nature) teaches Parents to take care not to put any Lead upon the Bellies of Children—but, on the contrary, rather to make them wear it behind. This will oblige them to keep in their Belly and at the same time hinder them from bending back."

In speaking of round shoulders, he states (Book II, page 115): "To hinder the Shoulders from growing round, you must take care to keep the Elbows well back, placed over the Haunches and the Chest forward." If one shoulder is higher than the other, he naively suggests (page 119): "Another method still, is to make him carry a little Ladder, made on purpose for that end, so as it may rest upon his Shoulder by one of its Steps. The Shoulder which supports it will rise, and the other will fall lower. These little Ladders may be proportioned to the Age and Body of the Child, and it will be a Pleasure and Diversion for him to carry it."

This latter suggestion would hardly fit in to the present-day order of activity, but it indicates what is suggested throughout, the thoroughness of the study of the child and treating of the special need with reference to the body as a whole.

With Andry, the obtaining or the preservation of the best function of the body, or the special part, was the basic ideal of that which represented orthopaedia. At his time the physician was expected to treat the whole individual, and with reference to the best function; nor did this ideal start with Andry, since, with the very early writing, the same general idea is manifested. A strong, healthy, well poised or well functioning body was the ideal of the early Greeks, as well as other civilizations. Also the correction of deformities had often been attempted before Andry's time. Hippocrates' method of the forcible correction of spinal deformities is probably known to most of you. It was reserved for Andry, however, who not only saw the special need of his work, but who had vision and influence enough, to start a movement with enough momentum so that we, today, nearly two hundred years later, are carrying on under the same colors.

During these nearly two hundred years, the principles of Andry have not always been prominent in the teaching of medicine, but they have never been lost, and from time to time individual observers have contributed something to the general knowledge that has been of help in correcting the existing deformities,—such as Stromeyer's tenotomy, or in better caring for the individual and thus lessening the tendency to deformity.

In fairly recent times such names as Hugh Owen Thomas and Robert Jones, of Great Britain; Alessandro Codivilla, and our contemporary, Vittorio Putti, of Italy; Lewis A. Sayre and C. Fayette Taylor, of New

York; Buckminster Brown and Edward H. Bradford, of Boston, suggest at once the names of men whose sane reasoning, always thinking of the end result with as perfect a functional general result as was possible to obtain, makes them worthy followers of Andry.

Always the idea of the best condition for function has represented a dominant note in all that was represented by Andry's conception and what has grown out of it. As the profession has developed in late years, with the responsibility for the care of the patient so much divided up, in the extreme development of specialism, many times the chief aim is to relieve symptoms with immediate results, without much regard for the careful study of the conditions leading to the best permanent function. During the World War in the care of the bone and joint injuries, with the severe muscle and nerve injuries, it very early became obvious that the general surgeon might be able to perform a more perfect operation than the orthopaedic surgeon who might be available; but, from the point of view of ultimate result, having in mind the usefulness of the part, the conditions were so strikingly reversed, that the responsibility for the care of such cases from the beginning of the injury to the transport home, was transferred, with the wish of the general surgeon, to the orthopaedic surgeon. The type of injury to be treated had rarely ever been seen by the orthopaedist any more than by the general surgeon, but the basic principle of training made the orthopaedic surgeon see from the very beginning an end result, and the special case simply demanded the adaptation of well understood principles to the War casualty. It was this basic training that forced Sir Robert Jones into such a prominent position in Great Britain. Good surgery without proper care before and after operation resulted in too many cripples, and each year Sir Robert was turned to more and more to improve the conditions. The results obtained by him not only established his position for the War need, but have led since to the development of the special hospitals and clinics all over England for carrying on the orthopaedic work of civil life.

This part, or what might be called the "Backgrounds", indicates carefully planned work based upon the special structure of the individual, leading to the best possible general function; deformities corrected, of course, but the prevention of deformities by careful training being the larger and more important part of the work. The special ideal of the work has been the best of which the individual was capable, recognizing that a healthy body was a good looking body. Much of the work that has passed has been fine; the challenge to us present-day workers is to demonstrate our fitness to carry on this work.

"FOREGROUNDS"

At this time when the medical profession has moved so far away from that which existed up to two or three decades ago, when the physician was in reality a general physician assuming the entire responsibility for the patient seeking his advice, a new adjustment is necessary. In the earlier

period the doctor was surgeon, as well as physician, meeting all the needs, knowing very little of what is called psychiatry today, but nevertheless practising the best kind of mental health. In special lines of work he was not the equal of the men of today, but no one can have witnessed the scattering of the responsibility for the care of the patient, with the many specialists sharing in it, without being aware that while much of the new is fine, much of the old was also fine. To try to get the best from each and make a still better is the great challenge for us today; and, until this is accomplished, we must expect to find our patients turning more and more to the irregular practitioners.

In our special line of work, with the great interest in the operative side of the work, with the general indifference to the non-operative, or to the operative case once the operation is performed, one can but wonder if the basic ideals which justify our work have not been lost sight of. If we are to see only the operation, leaving the after-care to the slightly trained house staff with the physiotherapy given by an entirely different department, of which we have little control or knowledge, we cease to be true orthopaedic surgeons, but just surgeons doing bone and joint work. If we still further recognize that three-fourths of the patients coming to an orthopaedic clinic are turned over to the junior staff, having little knowledge of the real condition, or too little time to carry out the treatment, the responsibility for which we are supposed to exist is being largely missed.

In many of our large clinics it would be far better to have the "chief" remain in the out-patient department and let the junior staff carry out the operative work. The skill required for this operative work is much less than that required for diagnosis in the many non-operative cases, with the planning of the appropriate treatment. Back cases, as usually seen, are uninteresting, because the average surgeon does not understand them. Once understood, they become interesting, and, intelligently treated, cease to be the burden of the clinic. The same is true with the average arthritic, or the paralytic, or the average foot case, or the average visceral case,—cases which respond so easily if rightly handled as to represent the greatest possible satisfaction to the physician. The indifferent care of most of these cases, in the average clinic, unless they can be called operative, not only is pathetic from the point of view of the patient, but represents a great waste to the hospital. The endless putting on of plaster jackets or braces, of strapping feet or knees, without first correcting the mechanical features that are at fault, is purposeless, and not only means waste of material and time, but, with so little gained, causes discouragement to both patient and physician.

The greatest need today for those of us who call ourselves orthopaedic surgeons, it seems to me, is to train ourselves so that what is involved in the "prevention" part of Andry's work is better understood; with the expectation that the increased knowledge of these two centuries will, if properly used, make it possible to carry the work in this line farther than was possible with Andry, just as is true with the purely operative part.

In such preparation the great need seems to be to carry our studies farther along the two lines emphasized by Andry,—first, the body types or varying anatomical structures, and, secondly, the function to be expected of the body in all its parts once the peculiar structure is known.

Once we realize that no two persons are made alike, the need of careful study of our patients along such lines becomes obvious and—fortunately for simplicity of study—while the individuals vary, there are, nevertheless, definite types which have their counterparts in the anatomy of the lower orders. That the text-book type does exist there can be no question; but since, apparently, this type has become the most perfectly adjusted to life as a biped, it is rarely seen in the doctor's office except as an accident case. Apart from this text-book normal, there are shown to be two main variations. One is slender in build, with a small skeleton, with flexible joints, with small muscles, with a highly organized nervous mechanism. This type, adjusted for quick moving, as well as quick thinking, should weigh as its normal from fifteen to twenty pounds less than the so called normal. Athletically, it is the short-distance runner, the hurdler, pole vaulter, the contortionist, etc.,—the "Uncle Sam" type. This type not only has the motor mechanism, bones, joints, muscles, etc., that are peculiar, but the viscera are different in shape and attachment from those of the text-book type. The stomach is tubular in shape, attached with a loose mesentery, the small intestine has from ten to fifteen feet of length instead of the text-book twenty. The large intestine is considerably shorter than the text-book type and has a much freer mesentery. The liver is small, with loose attachments. The skin is soft, and the hair, which is usually abundant, is usually soft and fine. The body is long in the torso in proportion to the thickness through, the neck and loin being particularly long. The arms and legs are usually long and slender, with feet naturally high-arched, and with hands slender, with long, tapering fingers. The face is commonly narrow, forehead high, and the ears usually large and prominent.

In contrast to this at the other extreme is the stocky or thick-set type with a skeleton heavy, joints relatively inflexible, muscles large, with coarse fibers. This type should weigh from fifteen to twenty pounds more than the text-book normal. Athletically, it is the wrestler, the weight lifter, the long-distance swimmer, etc.,—the "John Bull" type. With this type the bones are large and the joints are made for inflexibility,—the "closely knit" individual. The viscera also have their peculiarities, with the stomach large and pear-shaped, held high under the ribs by its attachments. The small intestine varies from thirty to forty feet in length, in contrast to the text-book twenty, and the large intestine is also considerably longer than the text-book type. The liver is large and heavy and held with firm ligaments well up under the ribs. The skin is coarser, with more connective tissue, and the hair is usually dropped early. The body is relatively short in the torso, is much thicker through than the slender, or the text-book type, and the neck is short and thick. The arms

and legs are heavier, with large, coarse-fibered muscles, with feet broad and low-arched, while the hands are broad, the fingers short, with much less difference between their lengths than in the slender or text-book type. The head is usually relatively small and round, with small, flat ears.

These two types, with the text-book type for the third, are fairly constant, although there is marked overlapping of features; one having a slender general type, may have a less flexible spine than would be expected. The viscera vary: the stomach and small intestine may be of the slender type, while the large intestine is larger and more like the heavy type. And thus we might go on, the essential feature being that there are these variations in the human family, and that, of those coming to us as patients, the large proportion will fall into the slender or stocky group.

Once these peculiarities are appreciated, some of the clinical observations become easier of understanding. An intestine of only ten feet will naturally be less able to absorb all of the food values than one of forty feet,—some justification for the individual easily growing fat, or the one remaining thin.

Also, an individual of twenty pounds heavier than the text-book normal, having a larger body to heat, would have as its normal a higher blood pressure than the slender type, with its smaller and lighter structures; and, in a less striking degree, the body temperature varies.

From the point of view of the general physiology, once one appreciates the different anatomical structures, there should be expected variations. The slender, quick-acting individual should have a more rapidly responsive physiological mechanism than would be required for the slower-moving, heavier type. This being the case, the slender should be expected to be able to liberate the energy more rapidly and is, therefore, the hyperglandular individual. In this type the basal metabolism should be from fifteen to twenty points above the zero as its normal. The slower-moving or stocky type should have as its normal a basal metabolism from fifteen to twenty points below the zero.

With such a study it is apparent that the way the body is used is of the utmost importance regarding its function. If used fully erect, irrespective of the special anatomy, the muscles of the trunk should be in balance, so that there should be no undue strain, and the curves of the spine should be such that the joints are not strained. In this position the head will be held well over the shoulders, with the chin drawn in, thus flattening the cervical spine, and thus tightening the deep cervical fascia, which is the suspensory ligament of the diaphragm. This, together with the proper use of the thoracic muscles, insures a relatively high position of the ribs, with resulting adequate space for the organs of the thorax, as well as adequate space under the ribs below the diaphragm for the abdominal organs. In this position the abdomen should be flat and not sagged, the pelvic inclination being about thirty degrees forward from the perpendicular, so that the weight is received upon the pelvis properly, with no strain of the pelvic joints nor the joints of the low spine to be expected.

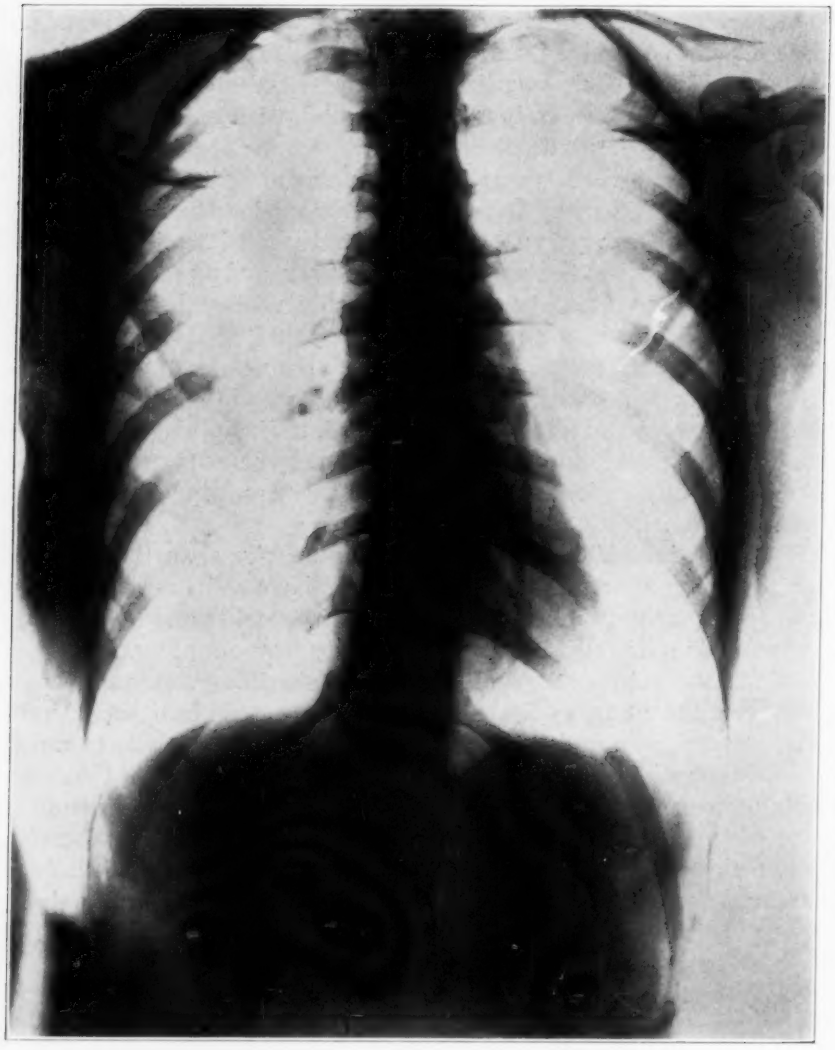

FIG. 1

Extreme ptosis of the heart and diaphragm, there being thirteen ribs in this case, with the diaphragm down to the last rib.

In this position the weight is received upon the feet so that the muscles are used in balance with strong, well poised feet to be expected.

In this position, with the upper chest held reasonably high, there is adequate support for the shoulder girdle so that the shoulder position should be good, with the scapulae flat upon the ribs at the back, with the circulation of the hands and arms not impaired, nor the nerve trunks unreasonably crowded or irritated.

If the body is used fully erect, the organs should be in positions similar to the text-book teaching, with the liver well up under the ribs, with the

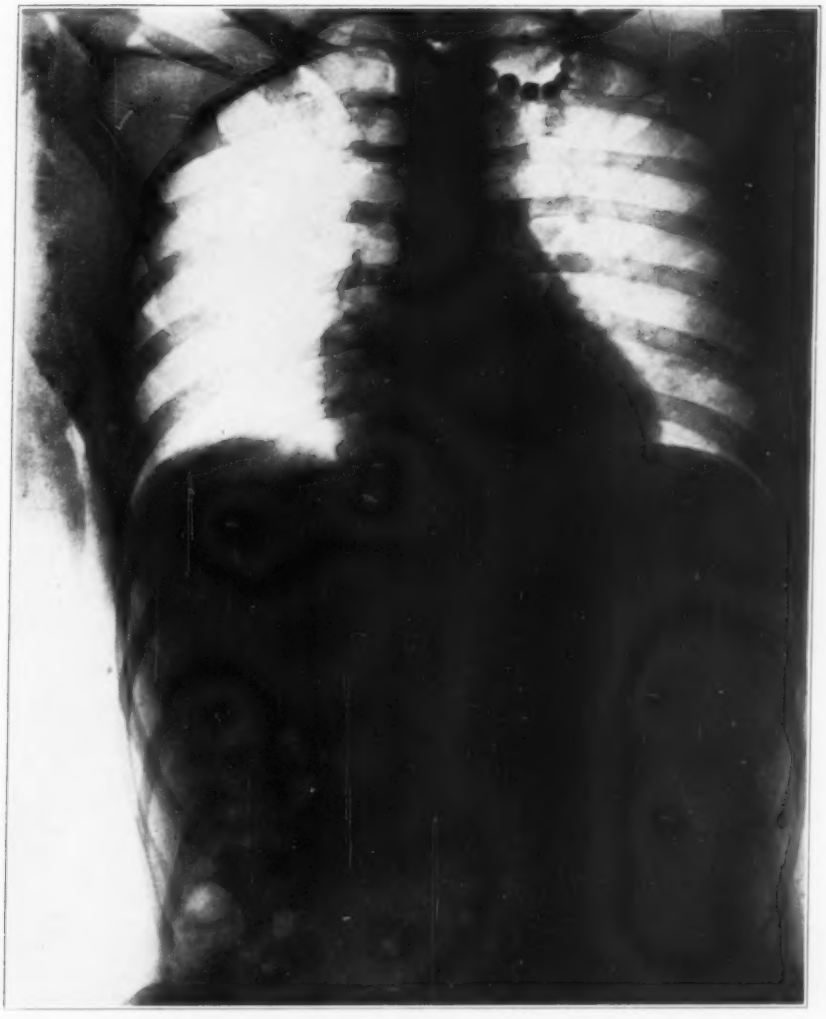

FIG. 2

The so called "text-book" normal, with the diaphragm between the eighth and ninth ribs at the back, the heart beginning at the fourth rib. Abundant space under the diaphragm and lower ribs for the abdominal viscera.

main axis horizontal, with the stomach high, the spleen under the ribs, the kidneys with the upper half resting against the posterior portion of the diaphragm, and with a firm mass of fat filling in the lateral spinal spaces, protecting as well as supporting the kidneys, the adrenal bodies, the pancreas, as well as protecting the splanchnic nerves and the upper abdominal blood vessels. In this position the relations of the stomach to the duodenum are such that drainage is easy, with the circulation unimpaired, so that normal function should be expected, with no tendency to ulcer.

When the body is drooped, however, the conditions are entirely changed,—the pelvis inclines forward more than is normal, the lumbar

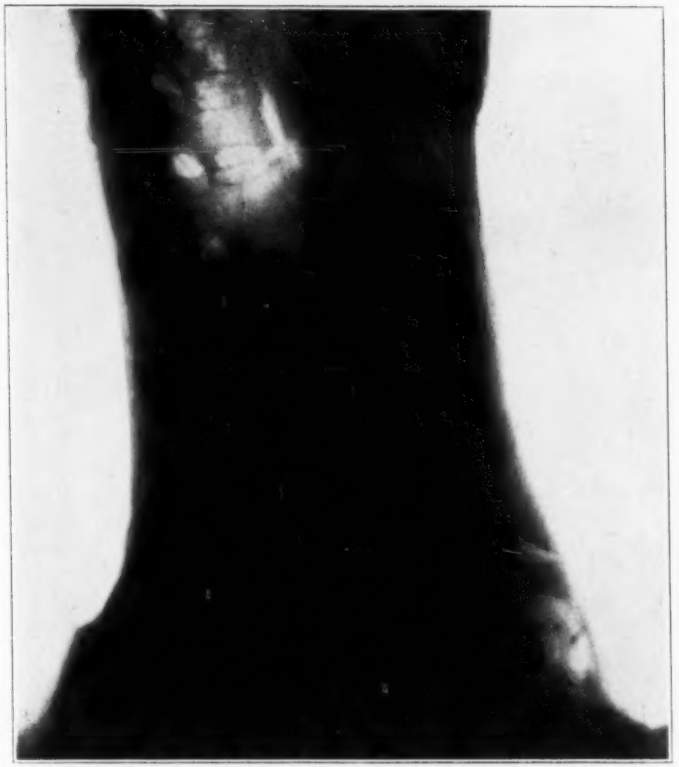

FIG. 3

Extreme ptosis of the heart and diaphragm, with very low position of the ribs, the anteroposterior diameter of the upper abdomen and lower chest much reduced, so that there is practically no room under the ribs and diaphragm for the abdominal viscera, which must, necessarily, be crowded downward, as is indicated here.

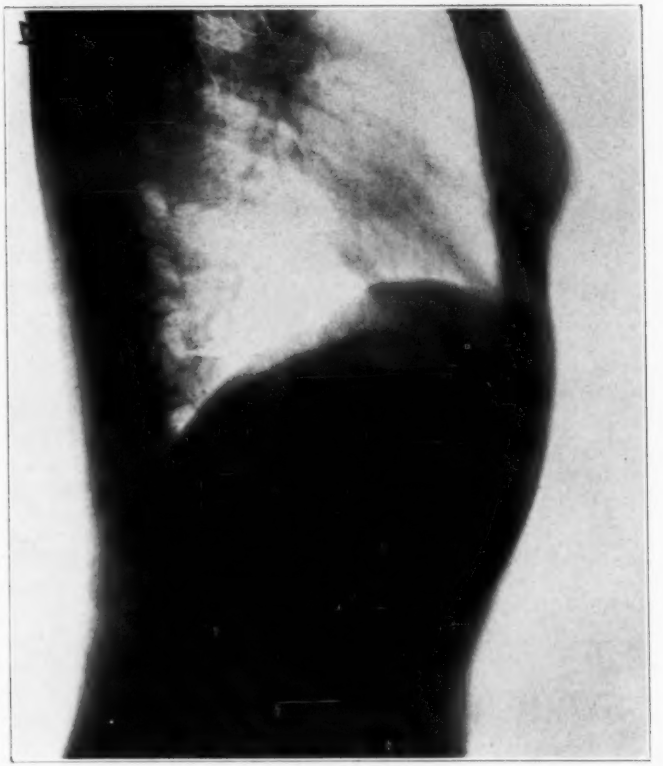

FIG. 4

Normal ideal position of the development with the arch of the diaphragm high, with adequate space in the upper abdomen, under the ribs and diaphragm, for the viscera. Note how shallow the lateral spinal spaces are under such conditions.

FIG. 5

Extreme ptosis of the abdominal viscera, the diaphragm being down to the last rib, the stomach very low. When such a position of the stomach exists, it must mean a low position of the diaphragm as well. The liver here shows with the axis vertical instead of horizontal. (Retouched.)

spinal curve becomes exaggerated, the dorsal spine is more rounded, the head is carried forward with increase of the cervical curve. The sternum and ribs sag; the abdominal muscles are relaxed; and with this, as well as the low position of the ribs to which the diaphragm is attached, the abdominal organs must be forced downward, while the thoracic organs are dragged downward.

In this position the shoulders are not properly supported upon the

FIG. 6

The relaxed position of the body with the marked forward tip of the pelvis. The thrust of the spine, being received on the top of the sacrum, tends to pull the upper part of the sacrum downward. Note the posterior position of the lower ribs with the resulting increased depth of the lateral spinal spaces.

thoracic cage and sag forward and in this position the weight is thrown upon the feet wrongly, with pronated or flat feet the inevitable result, while the same faulty mechanics results in strain or relaxation of the knees.

From the point of view of the general physiology, the degree of sag of the diaphragm is important and is shown in Figure 1, many times dropping to the level of the last rib at the back. In contrast with this is the normal (Fig. 2), with the diaphragm between the eighth and ninth ribs at the back. Under such conditions, and with the lesser sags, the condition is similar only less in degree; the space in the upper abdomen is markedly reduced (Fig. 3). There is no longer a space under the ribs (Fig. 4) for the liver, and, as it is forced downward, it commonly rotates, the right side dropping down (Fig. 5), so that the main axis is many times vertical instead of the horizontal of the supposed normal. In this position not only is the gall bladder placed with the rounded end downward, but the drag upon the ducts must be a factor in interference with its function. Also in the sag of the liver, with the twist of the organ, the possibilities of harmful drag upon the portal vein or the hepatic vessels must be readily apparent.

With such a position of the diaphragm, the stomach is forced downward (Fig. 5) and the oesophagus is put upon the stretch. If it is the tubular type of stomach, the sag will lead to the J-shaped stomach so

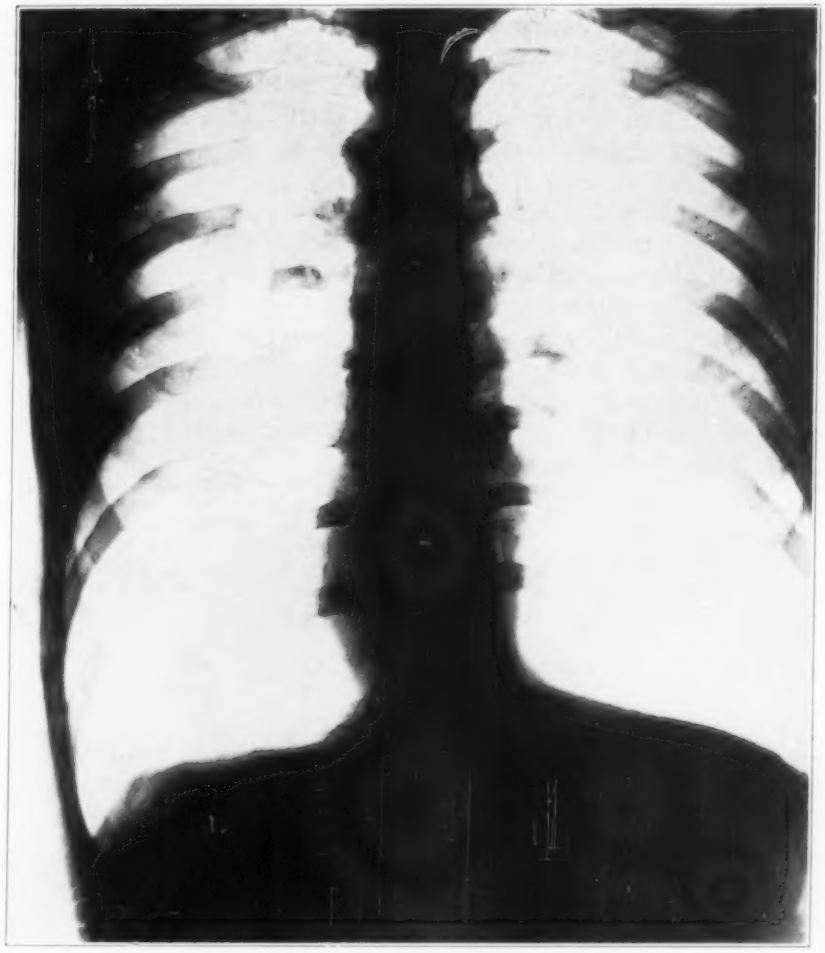

FIG. 7

Extreme ptosis of the heart and diaphragm, the diaphragm at the last rib, the heart vertical in its axis.

commonly seen, but when that is found in the pelvis, or very low, the diaphragm will be down also. With the lowering of the diaphragm, the kidneys, which lie with their upper halves against the lower posterior portion, must be tipped forward and forced downward; the kinks of the ureters are easy to understand, while the possibility of drag upon or interference with the blood vessels serving these organs might offer an easy explanation of many of the kidney symptoms. The orthostatic albuminuria with its quick correction, following the correction of the sagged position, should at least be suggestive of the cause of some of the more serious diseases. With the sag of the diaphragm, the low ribs, which should incline forward and downward, forming a basket-like support for the liver, spleen, stomach, and kidneys, as well as making the lateral

spinal spaces in the upper abdomen relatively shallow, are changed. Under the normal conditions, the pancreas, with its horizontal axis crossing the spine as it does, has the two ends on the two sides well supported, with no unnatural drag upon the middle portion over the spine. With the diaphragm sagged, not only are all of the organs crowded downward more or less, but the ribs drop downward and backward, not only losing entirely the basket-like support for the organs but, with the changed posterior position of the ribs (Fig. 6), the lateral spinal spaces are deepened, so that the two ends, the head and tail of the pancreas, must sag backward and produce drag upon the middle portion as it crosses the spine. This, together with the crowding downward of the other organs, is entirely suggestive as a cause of the imperfect function of the pancreas with sugar in the urine, and with the disappearance of the sugar after the correction of the body sag. This is suggestive, at least, of lines of study for the more serious forms of such disease.

FIG. 8

Extreme ptosis of the heart and diaphragm with necessary ptosis of all the abdominal viscera. Note the heart nearly horizontal in contrast to Fig. 7.

One of the very important of the abdominal blood vessels is the coeliac axis, coming off as it does from the anterior part of the aorta and sending its branches to the liver, stomach, pancreas, and spleen. The beginning of this artery is at the point where the lower portions of the diaphragm arise at the sides of the spine and cross to form the arch under which the aorta passes. With the extreme low position of the diaphragm, this arch of the fibers of the diaphragm must be dragged downward with such possibility of interference with the coeliac axis that it may very well be a factor in the disturbance of the stomach, pancreas, spleen, and liver.

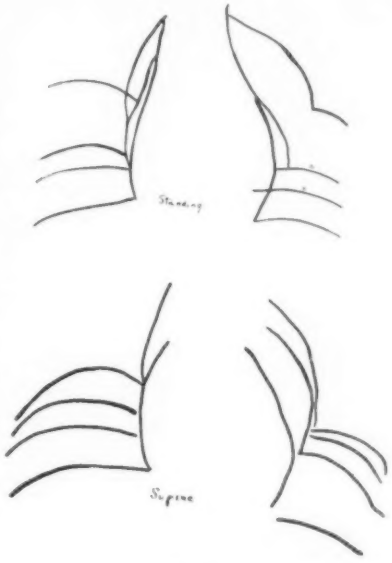

FIG. 9

Fluoroscopic tracings of the diaphragm taken with the patient standing, and lying upon the back. In neutral breathing the excursion of the diaphragm should be about one inch to one and one-half inches, and about midway between full inspiration and full expiration. When lying down the extreme range of motion should be somewhat less.

Under these same conditions of sag the intestines, both small and large, must be crowded downward with natural formation of twists or kinks especially at the hepatic and splenic flexures, and at the same time the abdominal viscera must crowd downward upon the pelvic viscera.

With such a sag of the body, not only must such changes of the abdominal structures occur, but the organs that rest upon the diaphragm will be drawn downward, the heart many times being at least three inches below its so called normal position (Figs. 1, 7, and 8). The arch of the aorta is drawn downward also, and mere demonstrable difference of position makes easy of understanding some of the circulatory disturbances of the head or arms. Under such sag, the blood vessels to these regions must be put upon the stretch.

In that which has been stated regarding the diaphragm, its position only has been mentioned, but its ability to perform its function is of the greatest importance. Some one has called the diaphragm the piston of the human engine and the illustration is not unreasonable, since the movement of the diaphragm, or its rise and fall, is essential to health. Since we realize that in the circulation the heart pumps the blood out but that the diaphragm pumps it back, the ability of both of these organs to perform their function is of the utmost importance. With the heart sagged, as has been shown, one should not expect the vigorous action of the best health, and with the diaphragm sagged, its range of movement or "stroke" must be limited, with resulting general disturbance. Since the diaphragm pumps the blood back to the heart through the compression

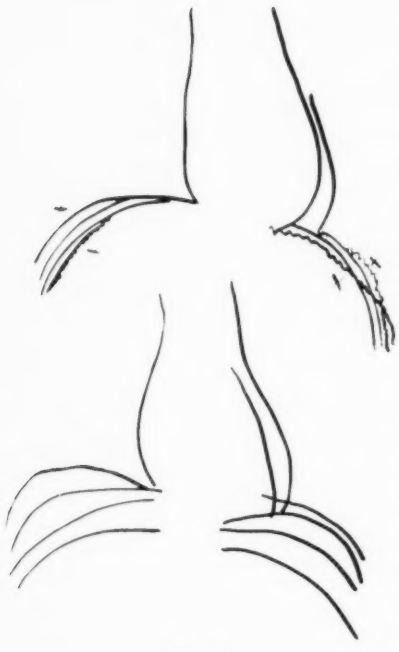

FIG. 10

Tracings as seen in the average case of ptosis of the heart and diaphragm resulting from the poor body mechanics. When standing the excursion of the diaphragm is extremely small, but when lying down the motion is not only freer but about the same on the two sides, indicating that there are no adhesions limiting its action.

of the veins with the inwardly opening valves, if it is not able to perform its function properly, the veins are not emptied and the heart is forced to pump against an increased pressure with, after a time, the weakening of the heart muscle from the overload, similar to the stale muscular condition of the athlete from overexercise.

In the examination of the patients, after the anatomical type has been determined, the next thing is to determine the position of the diaphragm with the heart and the range of motion of the diaphragm. This latter feature is determined by using the fluoroscope, over which tracings on paper are made, showing the up and down position of the diaphragm in ordinary breathing, and also the extreme possible range at full inspiration and expiration. The tracings are taken with the patient both standing and lying (Fig. 9). The ideal tracing should show a range of motion in ordinary breathing of from an inch to an inch and a half, this being about midway between the extremes of inspiration and expiration. With the ideal, the extreme range is more in the standing than in the lying position, and the lines should be generally horizontal, the outer part of the lines being on about the same level as the center.

With the sagging of the diaphragm, not only is the position of both this and the heart low, but the range of motion is less (Fig. 10), the lessening being much more marked in the standing than in the lying positions, unless there are adhesions above or below holding the diaphragm. Not only is the movement shown in the tracing less, but the neutral position is near or on the extreme low point and the sides slope downward well below the level of the central points.

Once the common low position of the diaphragm is recognized, and the limited range of movement is appreciated, the general venous congestion should be expected. Since the diaphragm pumps the blood from the veins to the heart, if it is not working properly, the veins will be full, showing superficially in the hands and also in the legs, where varicosities are common. That which shows so plainly on the surface of the body must occur wherever there are veins, with natural disturbances of the function of the viscera.

In such a lecture the time does not permit of the analysis of the symptoms referred to the special organs, but, with the appreciation of the faulty position of the organs which can be easily demonstrated, together with the circulatory changes which must result from the equally demonstrable imperfect action of the diaphragm, it should make suggestions at least in explanation of the many symptoms found with the patients.

Naturally, in the examination of the patients, the usual routine should be carried out, with the numerous tests made for whatever value they may possess, but with all this an examination of the patient should be made to determine the special type, as well as to see how the body is used. For this latter, the clothing should be largely removed and the patient examined standing, the examiner noting the general standing position, whether or not the body is erect, whether or not the chest is high and rounded forward, whether or not, in breathing, the circumference of the chest in the neutral or speaking position is midway between full inspiration and expiration. In poor health, with the usual drooped position, the neutral position is near full expiration. In the examination it is also important to estimate the diameters of the chest at the tip of the sternum, the ideal for health being with the anteroposterior diameter about two-thirds of the lateral; to note the circumference of the body at the umbilicus,—this should not be larger than the circumference at the tip of the sternum; to note whether the abdomen is firm and flat in the upper part, as is normal, or relaxed and prominent; at the same time noting the angle formed by the costal cartilages with the tip of the sternum, which for best health should be about ninety degrees.

Care should be taken to note also the position of the pelvis and whether the buttocks are unduly prominent. The hips and low back should be relatively flat, the inclination of the pelvis being about thirty degrees forward from the perpendicular. Naturally, the spine should be noticed, whether or not the curves are reasonable, and especially whether the head is held erect well over the shoulders or protrudes forward. The position of the feet is also important; flat or pronated feet will be more or less certain if the body is drooped.

After the standing position has been checked, the examination should be made lying down, at first upon the back, with not more than one small pillow under the head. In this position, the position of the ribs with the costal angle should be noted, and the low position at the sides should be checked,—in the much sagged body the low ribs often being in contact with the crests of the ilia. With the palpation of the abdomen and upper pelvis, it should be particularly noted whether or not there is much firm fat in the upper lateral spaces of the abdomen. In normal health this region should be firm with much substance between the two hands as palpation from front to back through the loin is made. In the drooped position of the body with the sagged diaphragm, there is usually almost no fat in this region, and with the displacement of the organs there is often

FIG. 11

Silhouette showing an individual with the general poise of the body not bad, but with the base or pelvis of the body tipped forward fully thirty degrees more than is normal, a condition which will inevitably produce weakening of the pelvic joints with natural relaxation of the muscles attached to the pelvis and the general droop shown in Fig. 12.

hardly more than the two layers of skin between the two hands. In correcting the condition in order to obtain good health, the treatment has not been completed until this retroperitoneal fat has been replaced with the hard, well developed upper abdomen mentioned.

After checking these features, the patient should be examined in the knee-hand position, noting in this the flexibility of the spine, the position of the low ribs, and how hollow the back is in the loin below the ribs. With proper development there should be no sag of the loin in this position, but when the body is drooped and the retroperitoneal fat is absent, the hollows below the ribs are usually marked.

In this position the abdomen should be palpated, since often in the patient with the low ribs, when lying upon the back, the crowding of the intercostal nerves causes reflex spasm of the abdominal muscles, which usually disappears entirely if the knee-hand position is taken and the ribs sag forward and upward.

After determining in this way the mechanics of the body and after seeing the roentgenograms of the spine with the heart and diaphragm, unless definite evidence of special and well understood disease is found, the rational procedure should be to correct the faulty mechanics of the body, including especially the spine and viscera, and to see what changes nature is able to bring about, of course, at the same time, giving such other treatment as may be indicated.

FIG. 12

Silhouette of a young woman of the same age as shown in Fig. 11, with the resulting relaxation of the pelvic girdle and the natural relaxation of the muscles attached to the pelvis. In this position the patient was standing as well as possible. Note, not only the position of the pelvis, but the relaxed position of the chest, the forward position of the head, and the marked sag of the abdominal viscera.

This correction of the easily demonstrated faulty mechanics of the physiology should be basic, whatever the special local lesion may be. If an arthritis, whether the common atrophic form or the less common hypertrophic form—since both are in part circulatory

FIG. 13

The position of the pelvis and lower spine are fairly good, but the chest is flat, the ribs low, the head too far forward. The degree of ptosis of the diaphragm in this case will be much less than in Fig. 12, but is an important factor.

and in part nutritive—this should be the first move. In the progressive paralyses, with the apparent passive congestion of the nerve cells, the faulty mechanics should be corrected, and the marked improvement commonly seen makes the real etiology of such cases at least strongly suggestive. If the thyroid is working wrongly, and since in the conditions described there must be congestion of the organ, the correction of the mechanics of the circulation may many times be expected to bring improvement. If the liver, or the stomach, or the pancreas, or the kidneys are not working rightly, and since the low position of the diaphragm must interfere with the circulation of these organs, the correction of the faulty mechanics should be made, at the same time using such diets or other measures as may relieve the special distress of the special organ, but expecting after normal mechanics is achieved that such special diets or other measures will not be necessary. In the same way with the serious anaemias,—with the extreme sag of the diaphragm, there would be congestion of the spleen as well as of the bone marrow, and while liver is indicated for the immediate need, the correction of the faulty mechanics which causes the congestion should be expected in most cases to relieve the condition and render special diets unnecessary.

FIG. 14

The extreme general relaxation with forward position of the pelvis, hyperextended knees, low ribs, forward position of the head, the typical position associated with functional glycosuria, orthostatic albuminuria, dysmenorrhea, poor digestion, etc.

In order to intelligently examine the patient and properly direct the treatment, it is important that the physician himself be able to see the faults and estimate their importance.

A few illustrations are shown that should be of help. Figure 11 is a silhouette of a young woman with the posture of the upper part of the body, at first glance, not bad. However, the pelvis, which is the structural base of the body and to which are attached all the trunk muscles, as well as all of the thigh muscles, is inclined forward fully thirty degrees more than normal, with the result that the thrust of the weight of the

FIG. 15

An individual of the stocky type, the extension of the body in this type occurring at the dorso-lumbar level instead of at the lumbo-sacral level.

spine must tend to drag the top of the sacrum downward and forward, strain of the sacro-iliac joints being an inevitable result. It is evident, because of the general poise, that the muscles in this case have not as yet given way, but they inevitably will and with it not only will the pelvic joints be strained but the ribs will be lowered, the head will come forward, and the trunk muscles as a whole will be relaxed, with a definite ptosis of the abdominal, thoracic, and pelvic viscera. Figure 12 shows the figure of a young woman of the same age, whose muscles have given out, with the results as stated above, and with the physiology as a whole disturbed. In both of these cases the individual stood as nearly fully erect as possible. In both the pelvis is tipped too far forward and this must be corrected before real improvement is possible.

In Figure 13 the base, the pelvis, and low spine are fairly well balanced but the chest is too flat, with resulting lowering of the diaphragm. The essential feature in the treatment of this case is to raise the chest, with the drawing backward of the head, in order to pull up the central portion of the diaphragm.

FIG. 16

An individual of the slender type with the body well poised, the muscles in balance, with adequate space in the upper abdomen for the different viscera, and with the diaphragm naturally high. Good health to be expected.

Figure 14 shows the general relaxed body with the pelvis and the lumbar spine too far forward, with the ribs very low, with the head protruding forward, and with the natural relaxation of the abdominal wall. Of course, in this type of case, the feet should be pronated or flat, and the knees sprung. It is this type in which one so commonly sees the orthostatic albuminuria, the functional glycosurias, the cystic gall bladder, and the general poor digestion, with much backache and leg ache.

These indicate a few of the types of posture as seen in the slender type of individual, the one most common today.

With the heavier built individual, the droop is always less in amount and the sag of the low back occurs, not at the pelvis and lumbosacral region, but in the upper lumbar and low dorsal region (Fig. 15). In

these cases the degree of sag is less, but, since the viscera are held more firmly in place by their ligaments than is true of the slender individual, the compression of the viscera may be more, with more serious disturbances many times the result. It is under such conditions that the cardiorenal diseases of middle life are so often seen. In this type of case the abdomen becomes heavy, but the degree of sag is less than in the slender type, except after long standing, in which cases the abdominal muscles are practically paralyzed, due to the crowding of the thoracic nerves, with the sagging of the ribs, and the twist of the head of the ribs at the costospinal joints.

Once these features are appreciated, it becomes simple for the physician to direct the treatment, with the well poised individual as the desire. Figure 16 shows the slender type well poised, and Figure 17 the intermediate type, also well poised, with the muscles all used in balance, with adequate space for all of the organs, and with the development of the upper abdomen satisfactory. Under such conditions no back nor foot strain should be expected.

FIG. 17

An individual of the intermediate or "text-book" type also with the body in excellent position for the mechanics of function.

Once these features are appreciated, the working out of the details of treatment can be left more or less to the individual physician; but under no conditions should the cases be simply turned over to a gymnast, who usually gives exercises which have muscle building for their aim. The aim in these cases should be to get the muscles in balance, so that proper tone will develop, and the physician should either give the exercises or indicate to the gymnast those which should be used.

For such work, it is important to have the body horizontal more than is usual while the muscles are regaining their tone. There should be from nine to ten hours in bed at night, with no pillow, or only a small one, used, the best position for sleeping, for the slender type, being upon the face, abdomen, or side. Beside this the horizontal position, flat on the back with the arms raised and hands under the head, should be taken for five or ten minutes several times daily. This, of course, tends to flatten the low back and to tip the pelvis backward, as well as to draw the head backward, and, by raising the arms and pulling upon the pectoral muscles, to spread the ribs and broaden the lower chest and upper abdomen.

In the beginning, if the faulty positions are extreme, such as the marked forward position of the pelvis, the horizontal position of the body should be used more, and, when lying upon the back, a large pillow should be placed under the knees to relax the hamstring muscles. If the ribs are

particularly low after the lumbar spine is flattened, a small pillow can be placed under the mid-dorsal spine when the special stretching positions are taken. At these times no pillows should be placed under the head, since it is desired to let the head sag backward and thus help to pull up the diaphragm and low ribs.

During these times of lying down, the exercises for developing the control of the abdominal and buttock muscles should be started. The lower abdomen should be drawn in and held while natural breathing is going on. Also the buttock muscles should be tightened with the attempt to draw, or roll the hips downward, this naturally helping to flatten the lumbar spine so that it will, ultimately, rest properly upon the body of the sacrum. After this has been acquired, exercises for drawing up the ribs should be given, first upon one side and then the other, partly to educate the lateral abdominal muscles, but also to spread the costal angle and raise the ribs laterally, and develop space ultimately for the viscera.

After control of these muscles has been acquired with the body recumbent, similar exercises should be given with the patient standing. During these exercises the patient should have in mind the attempt to draw in the lower abdomen, to draw down the hips, to raise the chest up and forward, and to stand as tall as possible. Once the ability to take the desired position is acquired, walking should be practised, the position of the body being held rigidly at first, but gradually relaxed until the easily well balanced position is natural.

At times, if the condition is marked, recovery is hastened by the temporary use of apparatus to relieve the muscle and ligamentous strain until these structures have been properly developed. Such apparatus does not mean putting on the common special corset, which simply compresses the parts, or braces, which fit the body as it is, but must tend to help in the improvement of the general poise of the body with the ultimate development of the supporting muscles and ligaments. Such apparatus should be used only until the desired muscle balance and tone have been reached.

In all of the treatment careful attention should be given to the natural habits of the patient, to see that in sitting and stooping, as well as standing, the body or torso is held without unreasonable bending at the waist line. Much "buckling" at this region makes impossible the proper development of the upper abdomen with the organs in place.

Naturally, while such general reconstruction is going on, the general condition must be watched, the rapidity of the recovery or the amount of exercise depending partly upon the frequently checked blood pressure and temperature, while symptoms indicating disturbance of special organs should, of course, be given proper attention.

With such an understanding, one would hardly think of fusing the low spine or pelvic joints without first correcting the faulty mechanics, since the faulty position of the parts leading to the strain means also, of necessity, faulty general mechanics, with imperfect weight-bearing on

feet and with imperfect position and function of the viscera. Also, one would hardly expect to correct a flat or weak foot without correcting the general poise of the body so that the foot muscles can work properly. Also, one would hardly expect to arrest and improve the common case of arthritis without first correcting the faulty adjustment of the viscera. Also, one would hardly see the need of a shelf operation for an old congenital dislocation of the hip without first correcting the marked forward tip of the pelvis which places the head of the femur much farther back than need be, especially since the disability of later years in such cases is not of the hip but of the back, because of the extreme lordosis. Also, in the intracapsular fractures at the hip, one should not expect the results to improve materially, irrespective of the local treatment, unless the structure of the bones is appreciated as part of the general disturbed physiology. Bone repair depends upon healthy tissues which the easily demonstrated atrophied bones do not represent. General treatment in these cases is of as much, if not more, importance than the local.

With such an understanding of the anatomy and of the mechanics of the physiology, many cases now not being relieved will become interesting, as well as yielding results that will be satisfactory, while many of the chronic cases now considered hopeless will yield a degree of satisfaction that will make our profession seem quite worth while.

In closing, let me urge you, in the treatment of your cases, to do all that general medicine indicates; but beside that to see that the "body mechanics" are such as to make health possible. Common sense tells one that this can do no harm, since the right use of a machine must be the desirable way; and many times with the human machine the right use gives nature all that she needs to give health.

The need of such work must be obvious and whether we, as orthopaedic surgeons are to do it, as Andry's teaching would seem to indicate, is for us to decide. The opportunity is great and, if we choose the operative work only, which is the easier, instead of the harder and more general, some other specialty or school will take this over. Our basic training should make us better prepared for this than any of the other groups, but of late, certainly, our vision has been so restricted that much of the large problem has been missed. If that which is here presented has helped you in getting the broad significance of orthopaedics, I am glad, and feel sure that something new in the way of satisfaction in your work will be yours.

THE INFLUENCE OF PERIOSTEUM ON THE SURVIVAL OF BONE GRAFTS*

BY KEENE O. HALDEMAN, M.D., SAN FRANCISCO, CALIFORNIA

Department of Surgery, Division of Orthopaedic Surgery, of the University of California Medical School

The controversy regarding the mode of repair of bone had, as its natural sequel, the dispute as to the survival and growth of the various types of bone grafts. Since Duhamel[1] first advanced the periosteal theory of bone repair two hundred years ago, this explanation has had many ardent supporters, the best known being Ollier[2]. Equally confident, though fewer in number, have been the proponents of the theory that bone is formed by the cell of the cortex. Macewen[3], in 1912, was one of the first to take issue with the conclusions drawn by Ollier. A third and very different hypothesis has gained ground in recent years. Bancroft[4], in this country, and Leriche and Policard[5], in France, have developed the idea that new bone following a fracture is formed extracellularly by the deposition of calcium salts in an oedematous embryonic type of connective tissue. The various theories of bone repair have been shown by diagram in a recent paper by the writer[6].

Whether or not a bone graft continues to live, and the parts played by its various components in the survival of the graft, is of great importance in the surgery of bones. Ollier believed that a piece of living periosteum-covered bone continued to live and grow after its transplantation to a bony bed. Barth[7], in 1894, took the contrasting view that all parts of a transplanted bone died and were replaced by a new growth of bone from the site in which the transplant was placed. His conclusion, which was generally accepted during the following decade, was that all varieties of bone material were equally successful. Therefore surgeons turned from living bone grafts to the implantation of dead bone. The accumulation of clinical results during this decade demonstrated the superiority of living over dead grafts.

Axhausen[8], on the basis of numerous experiments, concluded that, although the greater part of a graft died, its periosteum survived, produced new bone, and established a vascular connection between the transplant and its bed. Macewen believed that the replacement of the dead portions of a graft was accomplished by the proliferation of osteoblasts from the graft itself. More recently, Phemister[9] and others have shown that the dead portions of a graft are transformed into living bone by the process of "creeping substitution" in which the periosteum, endosteum, and cells of the haversian canals of the graft all play a part. This process is doubt-

* This work has been conducted under a grant from the Christine Breon Fund for Medical Research of the University of California.

TYPES OF BONE GRAFTS				
Advocated on Basis of Clinical Experience or Experimental Work				
Cortex & Periosteum may include endost.	Cortex & Endosteum	Osteo-periosteal	Periosteum only	Miscellaneous Types of Graft
Axhausen (exper.)	Brown & Brown (exper.)	Delageniere (clin.)	Berg & Thalhimer (exper.)	Brooks 2 stage graft (clin.)
Berg & Thalhimer (exper.)	Cohn & Mann (exper.)	Dorrance (clin.& exp.	Burman & Umansky (exper.)	Klinkerfuss callus graft (exper.)
Brooks (exper.)	Gallie & Robertson (clin.)	Ollier (clin.& exp.)	Mock (clin.)	Markelow heterogenous (clin.)
Davis & Hunnicutt (exper.)	Macewen (exper.)			Straub epiphysis (clin.)
Haas (exper.)	McWilliams 1921 (clin.)			
Hey Groves (clin.)	Speed (clin.)			
Jessen (clin.)				
Kartaschew (exper.)				
Leriche & Policard (clin.)				
Lexer (clin.)				
Mayer & Wehner (exper.)				
McWilliams 1914 (exper.)				
Phemister (exper.)				
Wereschinski (exper.)				

TABLE I

less aided by the ingrowth of bone from the bed in which the graft is placed.

As the survival of a transplant depends upon the inclusion of elements having the power of independent growth, the type of transplant employed by a given surgeon will be influenced largely by his views regarding the osteogenic properties of bone. The foundation for the transplantation of bone was laid by Ollier[2] in 1867, whose results are reported in two volumes, one having to do with experimental and the other with clinical observations. Much experimental and clinical evidence has accumulated since his time. The various methods of bone transplantation, their advocates, and the basis for such advocacy are shown in the table. Doubtless this represents but a small fraction of the papers published on the subject of bone grafts, but it includes the majority of those based on experimental work or extensive clinical analysis. For further information regarding the history of bone grafting, the articles by Hey Groves[10], Keith[11], Berg and Thalhimer[12], and Burman and Umansky[13] are suggested. A most thorough analysis of the results obtained clinically in 1390 cases of various types of bone grafts was made by McWilliams in 1921[14]. The experi-

ments to be reported below were designed to trace the fate of the different types of bone grafts under conditions resembling those found clinically, in the hope that conclusions might be drawn regarding the relative importance of periosteum, cortex, and endosteum to the success of the graft.

METHODS

Bone-graft operations were performed on twenty-two rabbits, the ages of which ranged between four and eight months. The method consisted of the production of a defect in each radius and the bridging of this gap by a graft taken from the tibia or fibula of the same rabbit. The ends of the graft were fixed in the open ends of the radius as an intramedullary graft. As two bone-graft operations were performed on each rabbit, it was possible to compare the various types of transplants under the same conditions. Anaesthesia was produced by the intraperitoneal injection of sodium amytal (0.060 grams per kilogram of body weight). The operations, which were done with aseptic technique, were followed by normal healing without any infections. No splints were necessary as the intact ulna prevented undue movement. X-ray pictures of both forelegs were taken at weekly intervals following the operation, until the fate of the grafts became apparent. The animal was then killed and microscopic studies were made of the radius and graft. In certain cases, animals were sacrificed after three or four weeks to show the earlier changes occurring around the grafts. Protocols of the experiments will follow, being more complete in those cases which are used for illustrations. The experiments fall into four groups.

PROTOCOLS

A. Grafts of whole fibula with periosteum, compared to whole fibula without periosteum or split fibula:

EXPERIMENT 25. A segment five-tenths of one centimeter long, including all the layers of the diaphysis, was removed from the middle portion of each radius. A section of the right fibula was excised and divided into two pieces, each one centimeter in length. One piece with its adherent periosteum was placed in the gap in the right radius as an intramedullary graft, while the other piece of fibula was freed from all periosteum and was used to bridge the gap in the left radius. The animal was killed 136 days after the operation, and microscopic sections were made at the sites of the bone grafts. The results of all experiments will be described later in the paper.

EXPERIMENT 26. Similar defects were produced in each radius and were bridged with pieces of the fibula. The graft on the right included the entire circumference of the fibula with periosteum, while that on the left consisted of a split piece of fibula with a small amount of periosteum. The animal was killed after 136 days.

EXPERIMENT 24 was similar to Experiment 25, the duration being 117 days.

EXPERIMENT 47 was carried out in the same manner as Experiment 26, but the animal died seven days after the operation.

EXPERIMENT 65 followed the same procedure as Experiment 25, and lasted ninety-one days.

EXPERIMENT 66 also resembled Experiment 25. The animal was killed after forty-four days.

B. Grafts of periosteum alone, compared to cortex alone or with endosteum.

EXPERIMENT 64. Following the removal of a segment, four-tenths of one centimeter in length, from each radius, a strip composed of the fibrous and cellular layers of the periosteum was dissected from the right tibia without including any visible pieces of cortex. This periosteal graft was anchored across the gap in the right radius by inserting one end of the strip into each fragment of the radius. A piece of cortex without periosteum or endosteum was removed from the right tibia and inserted across the gap in the left radius. The animal was killed fifty-eight days after the operation.

EXPERIMENT 79, lasting forty-six days, was performed in a manner similar to the preceding experiment except that the periosteum was removed from each radius for a distance of five-tenths of one centimeter from the defect. In this case the graft to the left radius included endosteum as well as cortex.

EXPERIMENT 80 resembled Experiment 79 and had a duration of forty-nine days.

EXPERIMENT 88 was identical with Experiment 64 except that the periosteum was removed from each radius for a distance of five-tenths of one centimeter from the defect. The animal was killed after twenty-eight days.

EXPERIMENT 90 resembled Experiment 79 and lasted thirty days.

C. Osteoperiosteal grafts compared to grafts of cortex alone or with endosteum.

EXPERIMENT 60. A segment, four-tenths of one centimeter in length, was removed from each radius. An osteoperiosteal graft consisting of two spicules of cortex with considerable adherent periosteum was taken from the right tibia and was placed across the gap in the right radius. A graft consisting of cortex and endosteum, but no periosteum, from the right tibia was used to bridge the gap in the left radius. The animal was killed seventy-four days after the operation.

EXPERIMENT 61 resembled the preceding experiment, but the animal was killed four days after the operation as it appeared moribund.

EXPERIMENT 68 was performed in the same manner as Experiment 60 and lasted forty-six days.

D. Grafts consisting of cortex and periosteum compared to those of cortex alone or with endosteum.

EXPERIMENT 62. Following the removal of the usual segment from each radius, a graft of cortex and periosteum from the right tibia was placed in the gap in the right radius. The gap in the left radius was bridged by means of a piece of cortex and endosteum from the tibia. The animal was killed fifty-two days after this operation.

EXPERIMENT 63. A piece of cortex alone from the right tibia was placed across the gap in the right radius, while the gap in the left radius was bridged with a tibial graft of cortex and periosteum. The duration of this experiment was seventy-two days.

EXPERIMENT 67. The gap in the right radius was bridged with a piece of its excised segment which had been denuded of periosteum but included the endosteum. This graft was placed with its endosteal surface facing away from the ulna. A piece of whole fibula, including periosteum, was placed across the gap in the left radius. The animal was killed after thirty days.

EXPERIMENT 69. The usual defects were produced in each radius and the periosteum was removed from the ends of the radius adjoining these defects. A piece of cortex and periosteum from the tibia was inserted across the gap in the right radius, and another graft of cortex and endosteum was used to bridge the gap in the left radius. The animal was killed forty-four days later.

EXPERIMENT 87 was performed in the same manner as Experiment 69, but was terminated twenty-three days after the operation in order to observe the earlier changes which take place in grafts.

EXPERIMENT 53 resembled Experiment 62 and had a duration of fifty-one days.

EXPERIMENT 70 was performed in the same manner as Experiment 69 and lasted sixty-three days.

EXPERIMENT 86 also resembled Experiment 69, with a duration of twenty-four days.

RESULTS

In describing the results of these experiments the same grouping and order will be followed as was used in the protocols.

A. Experiment 25 has been chosen as an example of a fibular graft. A series of postoperative x-ray pictures (Fig. 1) shows that the defect in the right radius, containing a periosteum-covered graft, became completely filled with new bone after forty-two days. The left radius, with a graft denuded of periosteum, showed a delayed and incomplete filling of the defect. Both grafts were represented by faint shadows in the roentgenograms after 136 days. In photomicrographs of the two specimens (Fig. 2) the graft in the right radius is seen to have survived as living bone which has united with the radius. No trace of the graft appears in the section taken through the left radius.

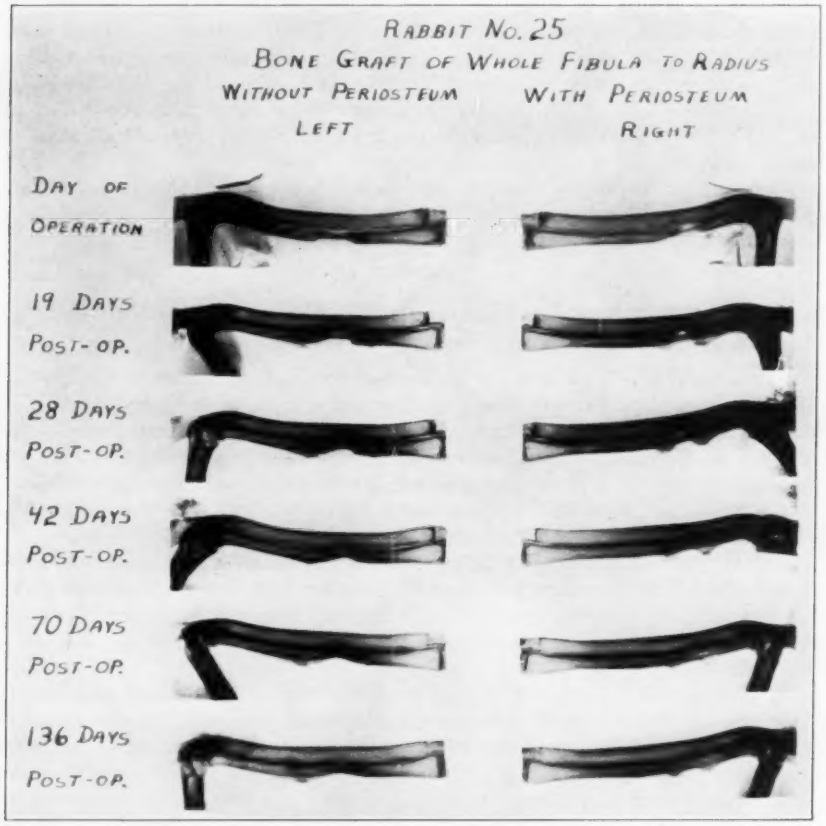

FIG. 1

Experiment 25. Roentgenograms.

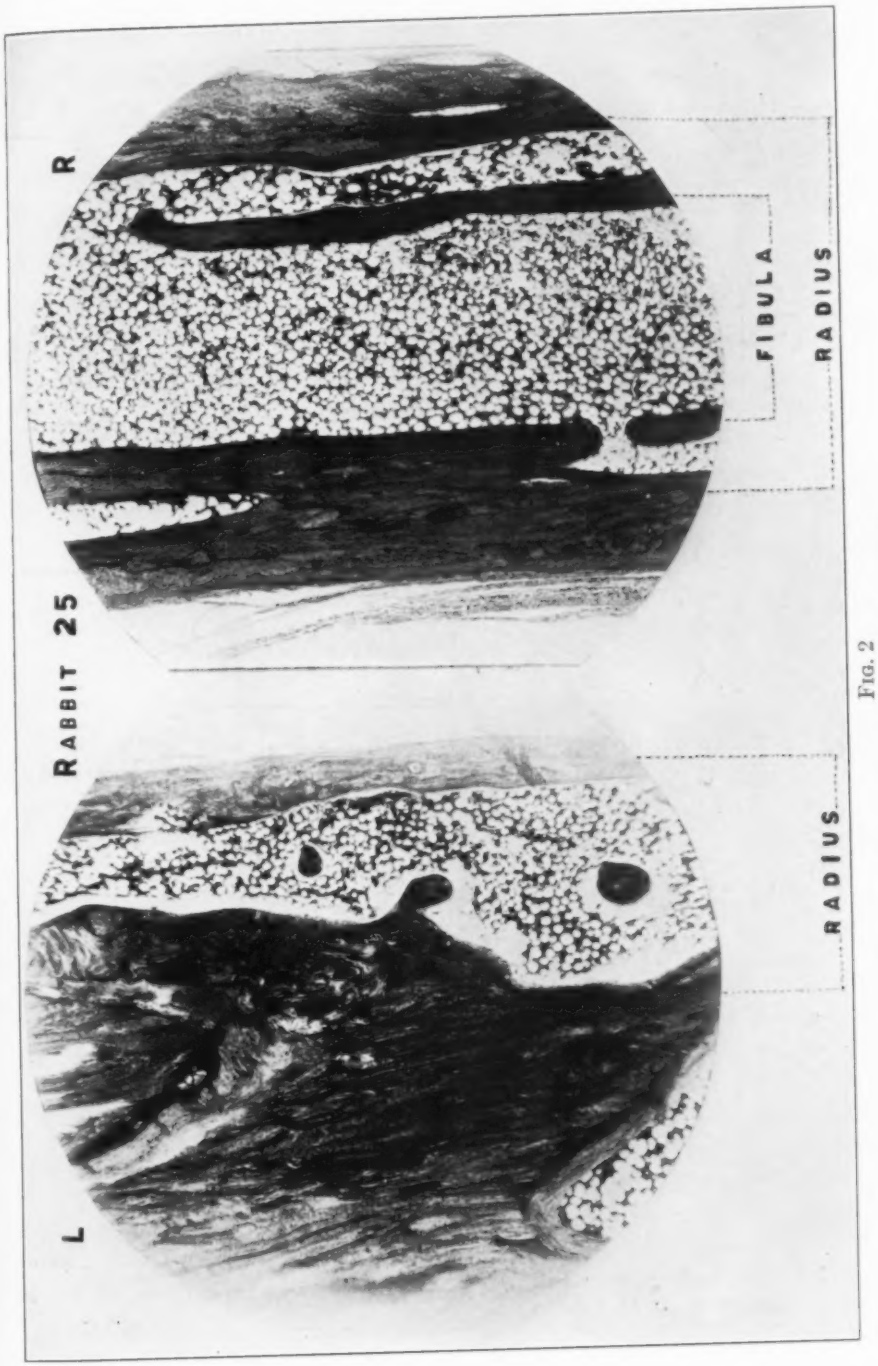

FIG. 2

Experiment 25. Photomicrographs.

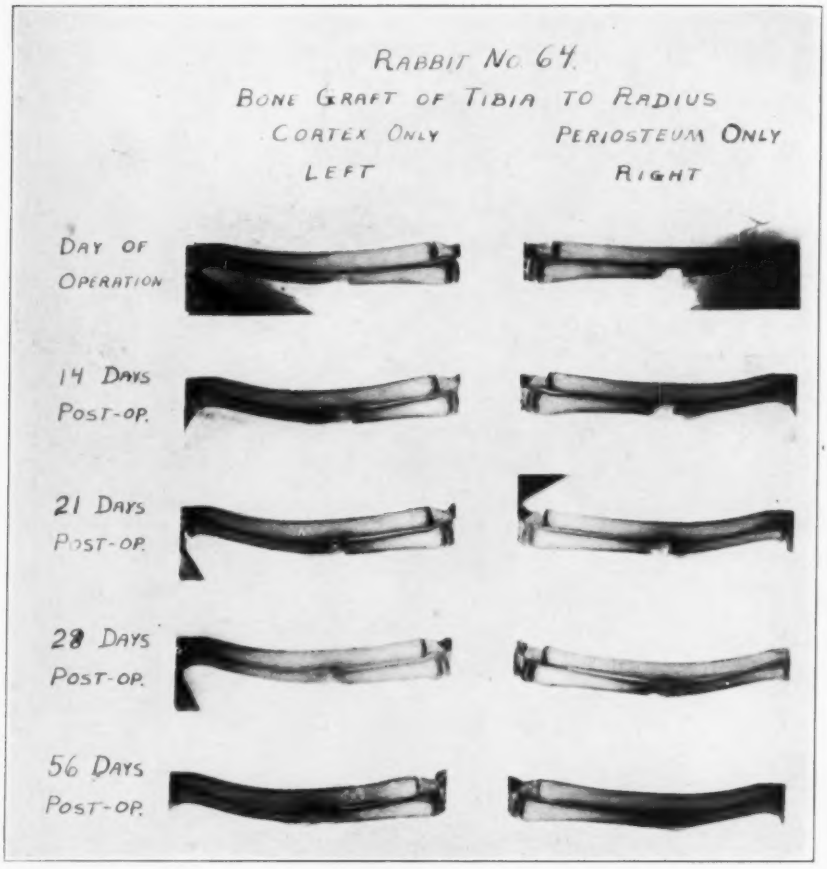

FIG. 3
Experiment 64. Roentgenograms.

In the case of Rabbit 26 there was a more rapid and complete closure of the defect in the right radius, which contained a segment of the whole fibula with its periosteum. The left radius contained a split piece of fibula which had less periosteum than would be included in the whole piece. On this side the closure of the defect was incomplete. In Experiments 65 and 66 the presence of periosteum on the graft apparently favored the survival of the graft and an early closure of the defect. The two other cases in this group gave inconclusive results. In Experiment 24 both bones of the left foreleg became fractured, and all fractures united in the same time. Rabbit 47 died seven days after the operation, before any callus could be demonstrated.

B. Experiment 64 is a representative of the group in which the periosteal graft is compared to the graft consisting of cortex alone. From x-ray pictures (Fig. 3) it is seen that the periosteal graft has completely filled the defect with new bone in twenty-eight days, while closure of the

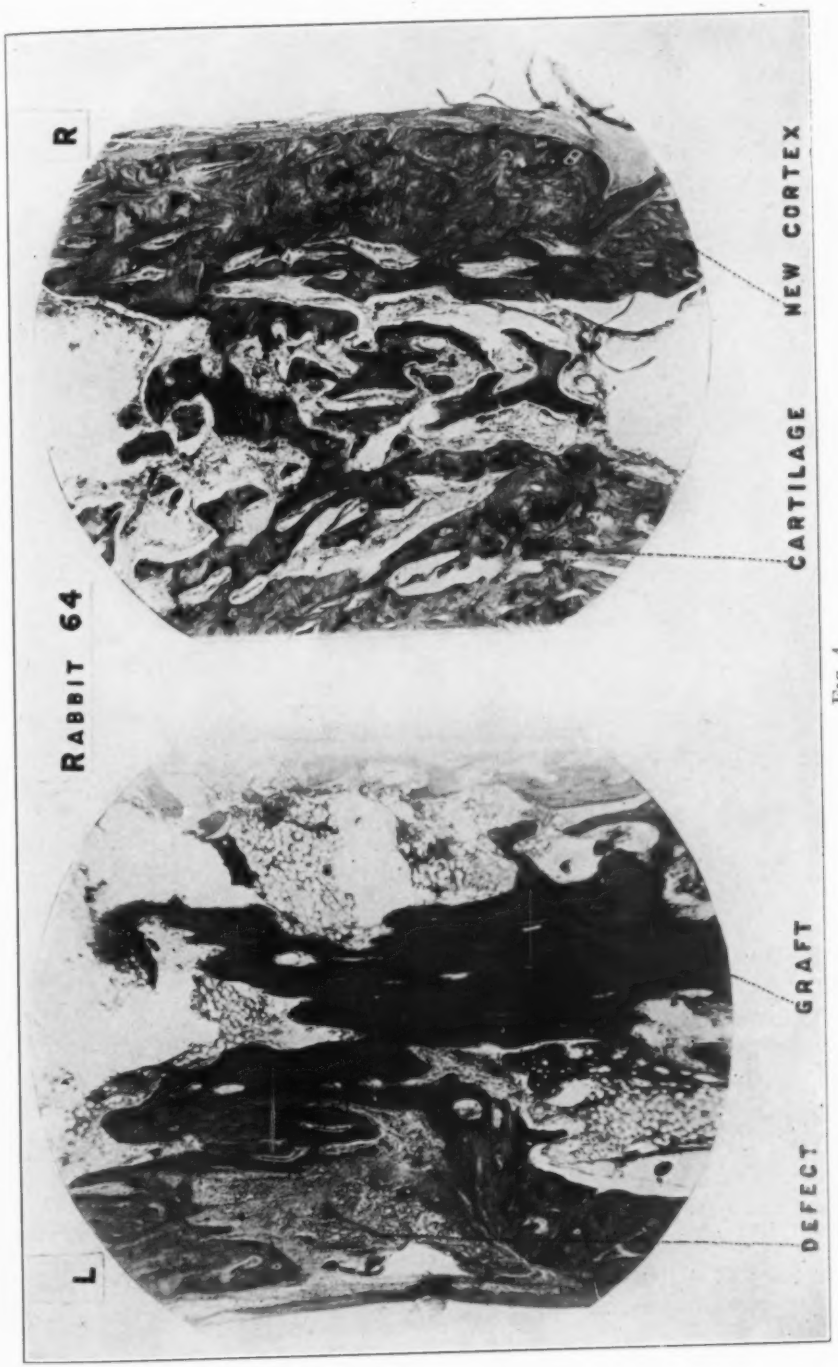

Fig. 4
Experiment 64. Photomicrographs.

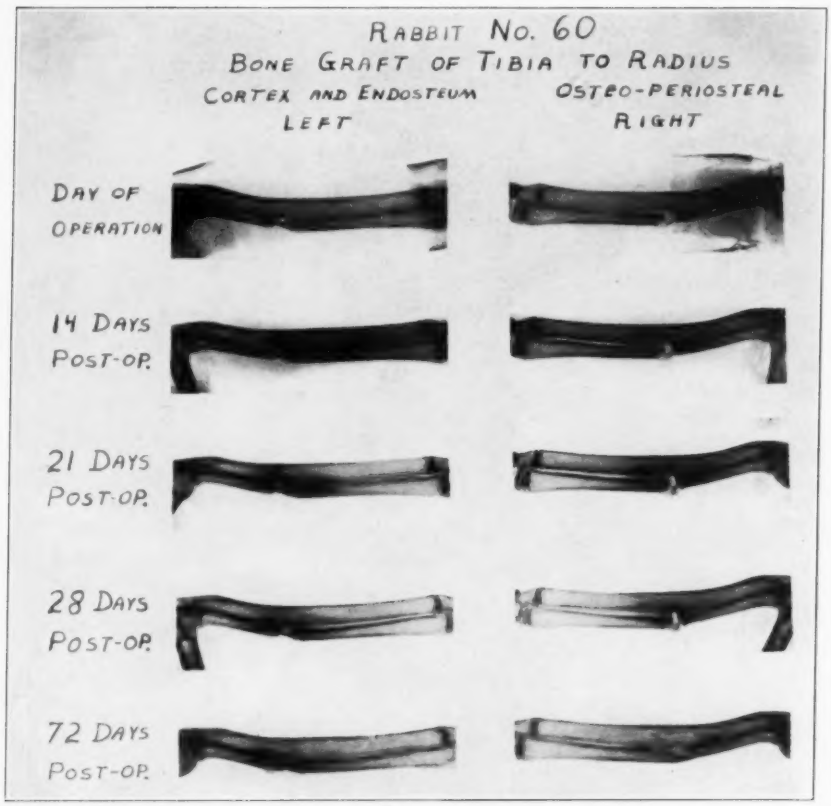

FIG. 5

Experiment 60. Roentgenograms.

defect in the left radius was delayed and apparently received little assistance from the graft of cortex. Photomicrographs (Fig. 4) confirm the above observations. It would seem that no pieces of cortex had been included in the periosteal graft, since no chips of dead bone can be seen. The defect in the right radius is completely filled with callus, the actively growing character of which is shown by small islands of cartilage cells scattered through the strands of callus. On the left side the defect is incompletely closed, and the graft shows little connection with the newly formed bone.

The four other examples of the periosteal graft showed, in every case, a complete closure of the defect after three to four weeks. On the opposite side, in which a cortical graft without periosteum had been placed, the defect became closed in four weeks in one case (No. 79), but healing was delayed in another rabbit (No. 80), and was not completed in the other two experiments (Nos. 88 and 90).

C. As a comparison of the osteoperiosteal graft with one composed of cortex and endosteum, Experiment 60 has been selected. The result resembles that of Experiment 64. X-ray pictures (Fig. 5) show the gap

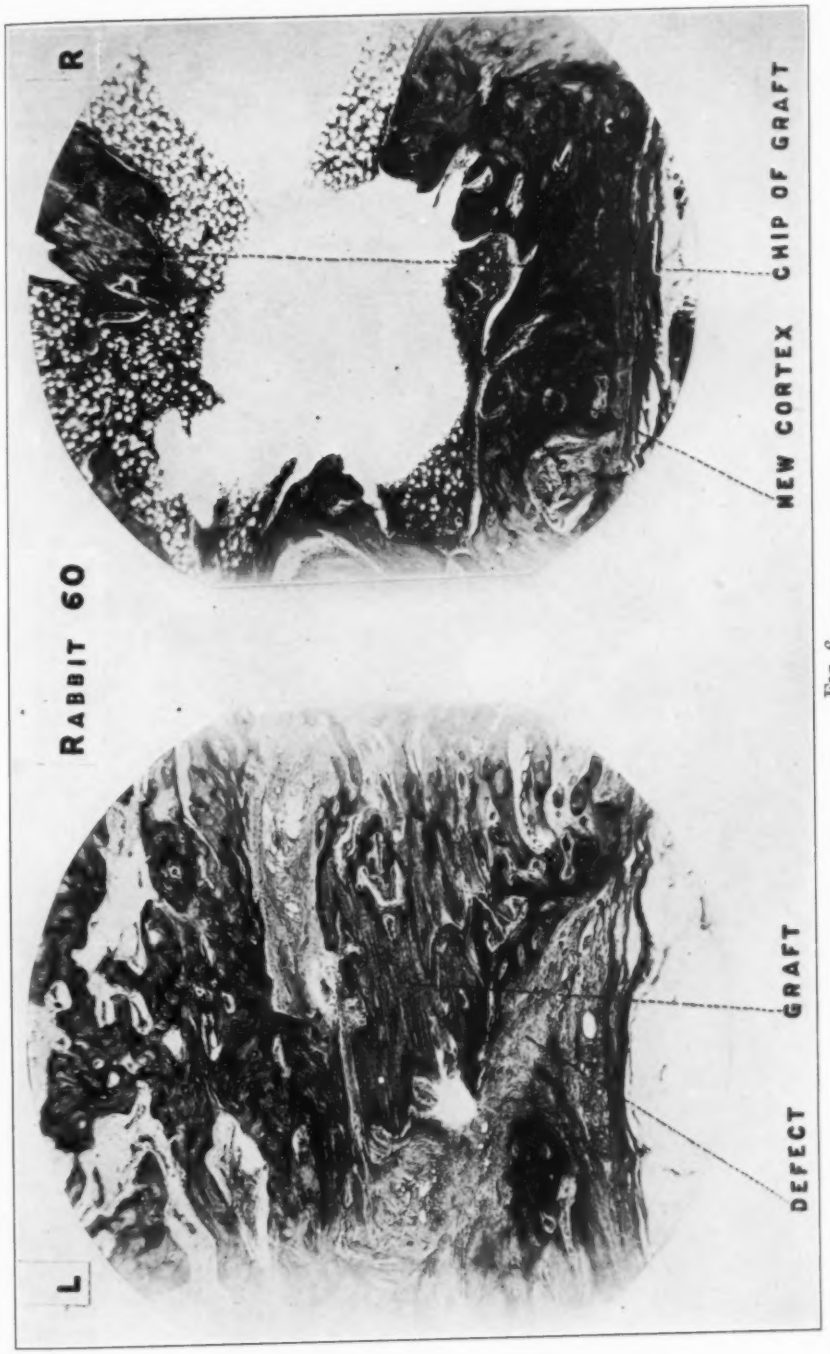

FIG. 6

Experiment 60. Photomicrographs.

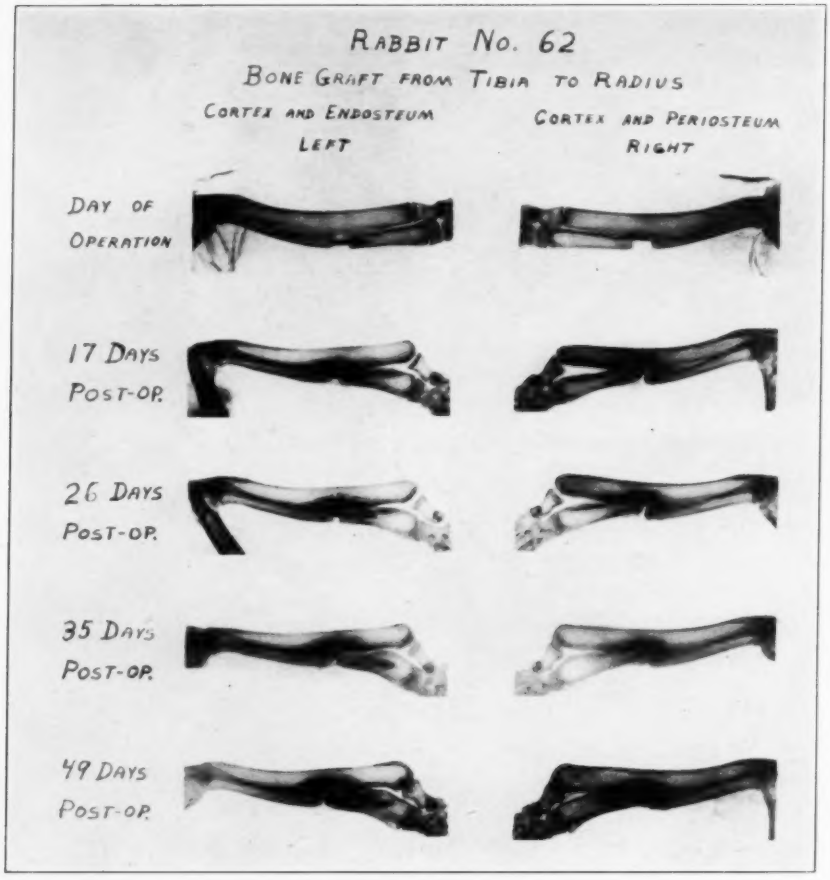

FIG. 7
Experiment 62. Roentgenograms.

in the right radius to be almost completely bridged by callus after twenty-eight days, with no visible callus on the left radius at that period. Closure of both defects appeared complete after seventy-two days. From photomicrographs (Fig. 6) it appears that the left radius has not completely united, and on this side the graft has little connection with the callus. A chip of the osteoperiosteal graft is seen to be surrounded by actively growing callus.

Of the two other examples of the osteoperiosteal graft, Rabbit 61 died four days after the operation, at which time there was no evidence of callus. The other rabbit (No. 68) showed a complete closure of the defect containing the osteoperiosteal graft after three weeks, while that containing the cortical graft required six weeks to close.

D. Three cases have been chosen to compare a graft of cortex and periosteum with one composed of cortex alone or with endosteum. In Experiment 62 the x-ray pictures (Fig. 7) show that the periosteum-covered

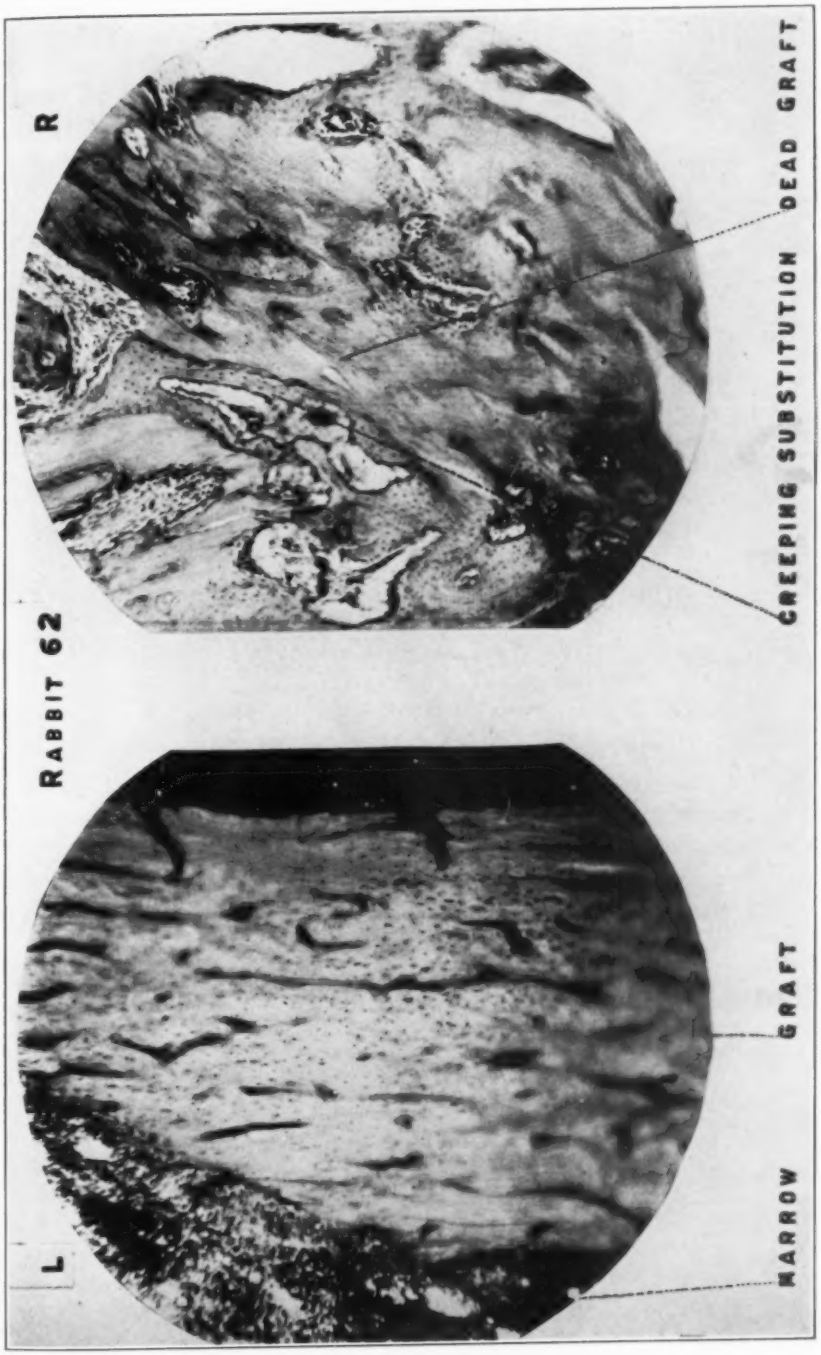

FIG. 8
Experiment 62. Photomicrographs.

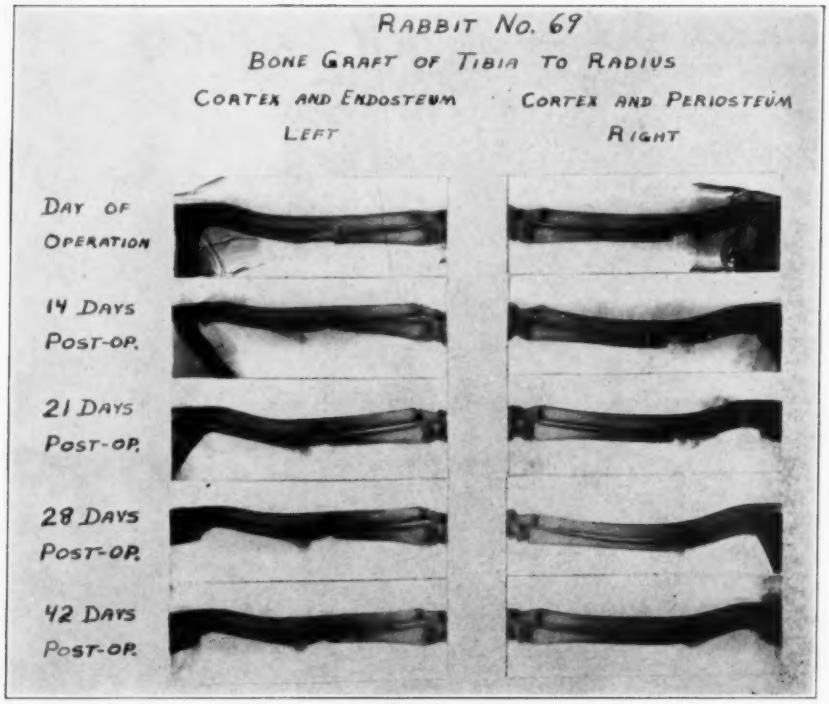

FIG. 9
Experiment 69. Roentgenograms.

graft united with the radius and helped to close the defect, while the periosteum-free graft became loosened in its bed and migrated along the medullary cavity to the distal end of the radius. Union of the left radius did not occur. In microscopic examination (Fig. 8) the graft to the right radius is seen to be undergoing "creeping substitution",—that is, the dead cortical portion of the graft is being replaced by living bone which spreads outward through the graft from enlarged haversian canals. The entire graft in the left radius appears to be floating free in the medullary cavity.

The x-ray studies in Experiment 69 (Fig. 9) give evidence of complete closure of the defect in the right radius after twenty-eight days, while the left radius is incompletely united after forty-two days. This impression is confirmed by the microscopic examination (Fig. 10). The periosteum-covered graft persists on the right side and is intimately connected with callus. No trace of graft is found in the left radius, and a condition of pseudarthrosis is present. The black area in the latter section represents cartilage.

An earlier stage in the healing of a bone graft is presented by Experiment 87. The x-ray pictures (Fig. 11) show a faint shadow of callus on the periosteal surface of the graft in the right radius after two weeks and after three weeks. No similar callus is seen on the other graft which did not include periosteum. The microscopic appearance with high and low magnifications is given in Figures 12 and 13. In these figures, the high

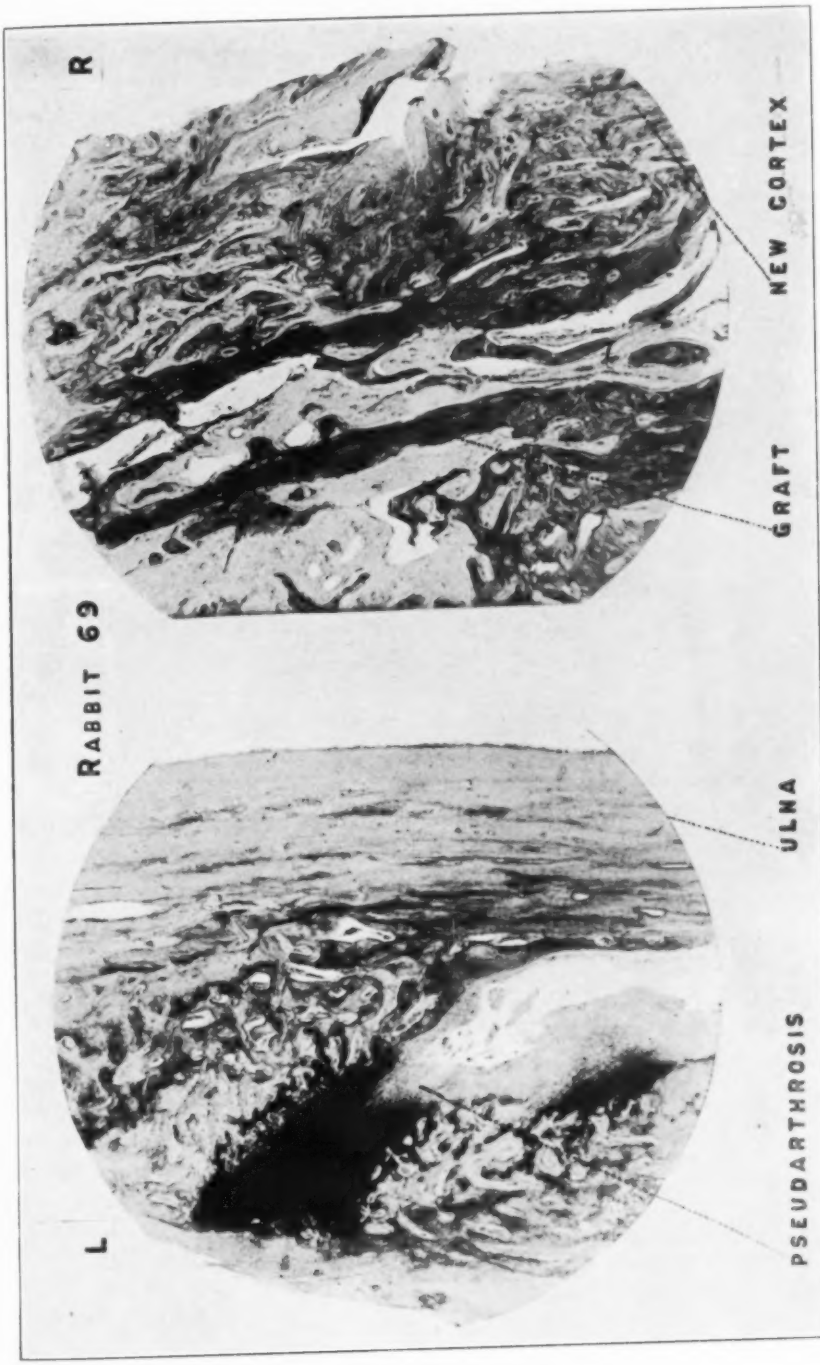

FIG. 10

Experiment 69. Photomicrographs.

FIG. 11

Experiment 87. Roentgenograms.

magnification includes the area which is designated by the dotted circle in the low-power view. The growth of periosteal callus from the surface of the graft in the right radius is clearly shown, while the periosteum-free graft in the left radius has given rise to no such callus.

Five other cases belong in this group. In Experiment 63, both defects became closed in four weeks. Both grafts were seen in microscopic sections ten weeks after the operation, although the left periosteum-covered graft was continuous with callus, while the right graft of cortex alone lay free in the medullary cavity. In Experiment 67, closure of the defect in the left radius, in which a periosteum-covered graft had been placed, occurred in three weeks, while the defect in the right radius, after four weeks, was incompletely closed. Both defects in Rabbit 53 became closed after three weeks and a small fragment of each graft was seen after seven weeks. Rabbit 70 showed complete closure of the right radius with periosteum-covered graft after three weeks, while the left radius required six to eight weeks for healing. The graft in the right radius appeared to take an active part in the closure of the defect, while the other graft played a passive rôle. In Rabbit 86, killed after three weeks, traces of callus are seen on the graft which included periosteum, but no callus is found on the other graft.

SUMMARY

In twenty-two rabbits, grafts taken from the tibia or fibula were transplanted to defects which had been produced in each radius. By weekly x-ray observations, and at the end of the experiment by microscopic sections, it was possible to compare different types of grafts in the same animal, namely, fibula, periosteum alone, osteoperiosteal grafts, and cortical grafts with or without periosteum.

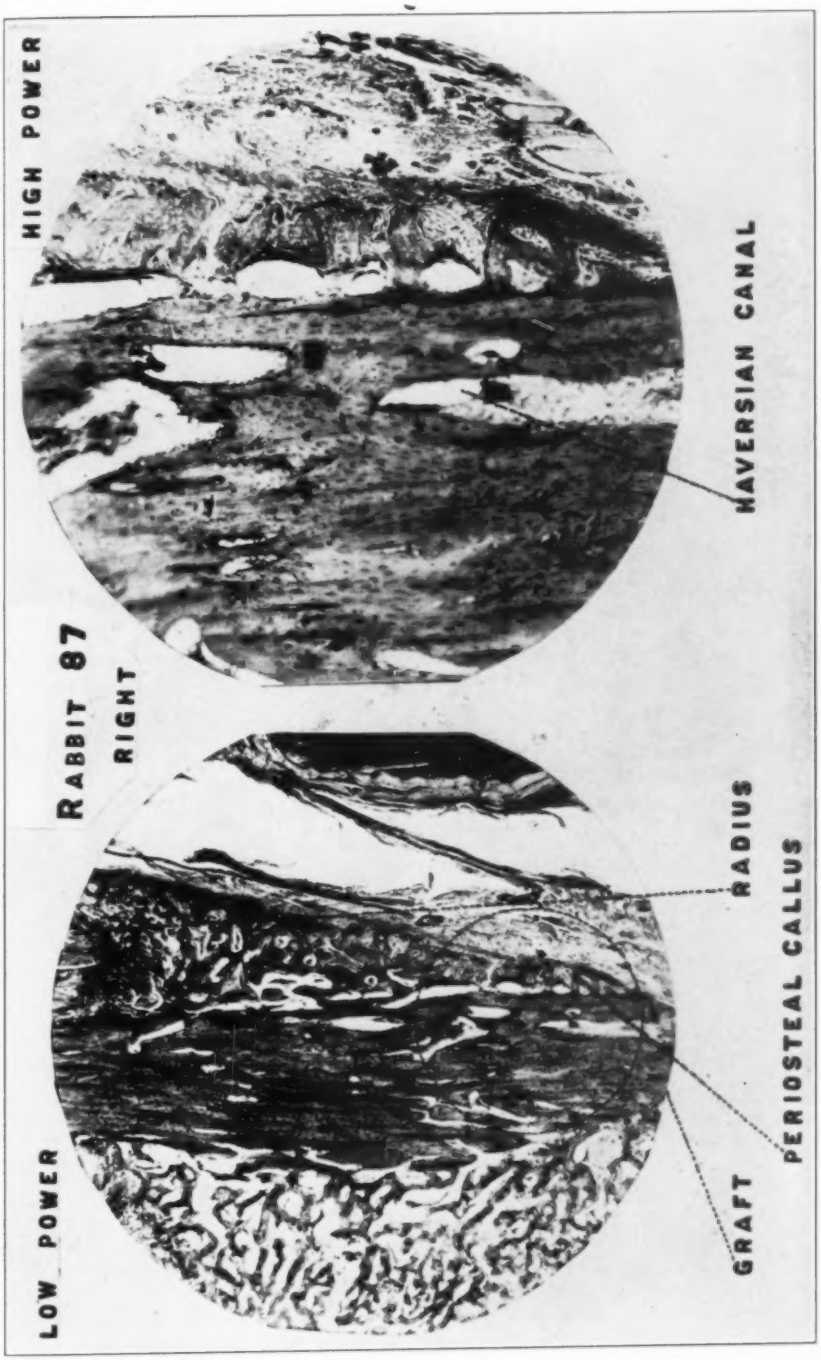

FIG. 12

Experiment 87. Photomicrographs of right radius.

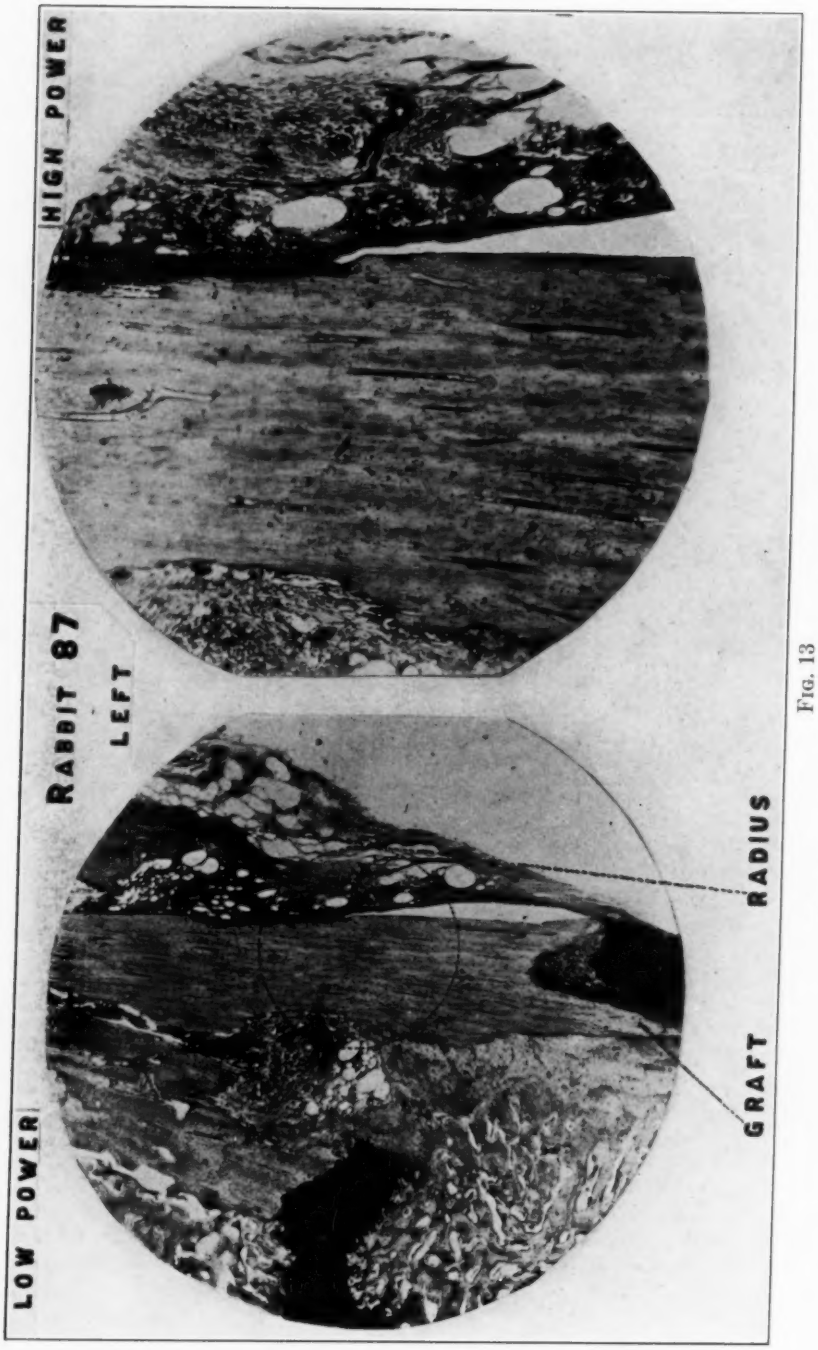

FIG. 13

Experiment 87. Photomicrographs of left radius.

It was found that a graft composed of the entire fibula survived longer and favored an earlier closure of the defect than did a graft of fibula without periosteum, or split fibula. A periosteal graft, free from bone, produced an early closure of the defect in every case. The osteoperiosteal graft also resulted in an early closure of the defect, apparently through the activity of the periosteum rather than the fine pieces of cortex which were included in the graft. A comparison of cortical grafts with and without periosteum showed clearly that the presence of periosteum on a graft favored the early closure of the defect and the survival of the graft.

CONCLUSIONS

1. Periosteum is the most important part of a bone graft, both as regards union of the fractured bone and survival of the graft.

2. In the absence of periosteum on the graft, union of the fracture is delayed or fails to occur, and the graft dies and is finally absorbed.

3. The bone cells of a graft die within a few days, after which the framework of the graft may be revitalized with living bone cells which spread outward from enlarged haversian canals; this process being called "creeping substitution".

BIBLIOGRAPHY

1. Duhamel, H. L.: Quoted by Sir Arthur Keith in Bone Growth and Bone Repair. British J. Surg., V, 685, 1918.
2. Ollier, L.: Traité Expérimental et Clinique de la Régénération des Os et de la Production Artificielle du Tissu Osseux. Paris, Victor Masson et Fils, 1867.
3. Macewen, W.: The Growth of Bone. Glasgow, James Maclehose and Sons, 1912.
4. Bancroft, F. W.: Bone Repair Following Injury and Infection. Arch. Surg., V, 646, 1922.
5. Leriche, R., and Policard, A.: The Normal and Pathological Physiology of Bone. Translated by Sherwood Moore and J. Albert Key. St. Louis, C. V. Mosby Co., 1928.
6. Haldeman, K. O.: The Rôle of Periosteum in the Healing of Fractures; an Experimental Study. Arch. Surg., XXIV, 440, 1932.
7. Barth, A.: Ueber Osteoplastik in Histologischer Beziehung. Arch. f. Klin. Chir., XLVIII, 466, 1894.
8. Axhausen, G.: Die Histologischen und Klinischen Gesetze der Freien Osteoplastik auf Grund von Thierversuchen. Arch. f. Klin. Chir., XXVIII, 23, 1909.
9. Phemister, D. B.: The Fate of Transplanted Bone and Regenerative Power of Its Various Constituents. Surg. Gynec. Obstet., XIX, 303, 1914.
10. Groves, E. W. Hey: Methods and Results of Transplantation of Bone in the Repair of Defects Caused by Injury or Disease. British J. Surg., V, 185, 1917.
11. Keith, A.: Bone Growth and Bone Repair. British J. Surg., V, 685, 1918.
12. Berg, A. A., and Thalhimer, W.: Regeneration of Bone. Ann. Surg., LXVII, 331, 1918.
13. Burman, M. S., and Umansky, M.: An Experimental Study of Free Periosteal Transplants, Wrapped around Tendon; With a Review of the Literature. J. Bone and Joint Surg., XII, 579, July 1930.
14. McWilliams, C. A.: The Values of the Various Methods of Bone Graftings Judged by 1390 Reported Cases. Ann. Surg., LXXIV, 286, 1921.

TRACTION-SUSPENSION TREATMENT IN FRACTURES

Certain Commonly Neglected Factors

BY ROBERT H. KENNEDY, M.D., NEW YORK, N. Y.

From the Surgical Service of the Beekman Street Hospital

The treatment of many fractures of extremities by traction suspension is one of the few developments of the war period, the value of which has been proved by its continued use in civil practice. Improvements in this method have been made since the War. Those who have had the opportunity to use it frequently and to learn its finer points find that it gives good results. Those who use it occasionally or carelessly are prone to belittle its value and to turn to other methods. It is no easier and requires no less training than open reduction. It perhaps presents less danger of a bad result for the surgeon who only occasionally treats a major fracture.

For the past nine years the same group of surgeons have been treating fractures at the Beekman Street Hospital, where the admissions are largely the result of traumatism. During this time over 3,500 fractures have come under our care. These injuries are often compound and come from a district where gas-bacillus infection is a frequent complication. We have a single operating room which is used for all types of cases. For these reasons we have not sanctioned open reduction as a routine. Once converted to traction suspension as an accepted method of treatment, we have developed a certain proficiency in its use, so that it is probably employed in some cases where other surgeons might not consider it necessary. During this period it has been used on over 200 patients, a number of whom have had traction on more than one extremity. Our aim in all cases is restoration of length and proper axis without rotation. Attention will be directed to certain errors noted as a result of this experience.

1. *Delay Before Application of Traction.*

We believe that traction should be applied at the site of accident no matter if, at a later date, some other method should be substituted. Findlay [1] of the Beekman Street staff has published the details of the routine which is used by our ambulance surgeons. As a result of following this plan, the roentgenographic examination which is made immediately after the patient reaches the hospital rarely shows overriding, and the muscles do not have a chance to go into spasm. Pain and shock are markedly less when traction and morphin are used, and the patient is ready earlier to be put into permanent apparatus. Less weight needs to be applied than is the case if even one hour elapses before traction is instituted. After twenty-four hours fifty to one hundred per cent. more weight is required to overcome the shortening. This means added and

unnecessary strain on muscles and ligaments, as well as increased discomfort to the patient.

2. *Lack of Continuity of Traction.*

The emergency traction must be continued until the permanent method of treatment is instituted. Our resident surgeons are allowed to release traction only if this is necessary to determine the site to be subjected to roentgenographic examination, after which it is immediately reapplied. The roentgenogram is taken with emergency traction in place. In the ward the clothes are cut away and the shoe removed under supervision of a surgeon and traction on the extremity is maintained manually whenever the hitch has to be loosened. The hitch is reapplied as soon as the extremity is freed of clothing.

When traction is the treatment decided upon, constant watchfulness is necessary in order that the desired pull be actually exerted. The pulleys must be so made and the rope of such a size that the latter does not slide sidewise and become caught between the sheave and the frame of the pulley. Knots and spreaders must be far enough distant from pulleys so that they do not engage against one another. The ropes attached to weight bags must not be so short that the bag becomes engaged in the pulley, nor so long that the bag can rest on the bed or the floor. Until we insisted that the same nurses remain on the fracture ward for long periods, we frequently found that when a patient complained of pain the nurse put the bag of weights on the bed to "let the patient rest for a while". If the distal end of a Thomas splint is allowed to rest against a pulley or a cross bar, the traction becomes fixed, rather than suspended, and the amount of actual pull is changed. After adhesive plaster with traction has been applied for two or three weeks, it will often separate from the skin quite suddenly letting up all traction and possibly allowing change of position of the fragments. This accident may be forestalled by watchfulness. All these errors seem unnecessary, but we have seen each of them occur. Although one man should have charge of the handling of an individual fracture, it is necessary that every intern, nurse, and orderly should know the rudiments of what we are trying to do and be ready to remedy any defect at any hour of day or night. The resident should inspect every traction apparatus on his morning and evening rounds for just such irregularities.

3. *Improper Amount of Weight.*

There is no routine amount of weight for a given fracture. This depends on the site of the fracture, the amount of muscle damage, the length of time since the fracture occurred, the weight and muscular power of the patient. Intertrochanteric fractures of the femur and fractures of the upper third of the leg require less weight than fractures lower down in these bones. A severe compound fracture with tearing or débridement of major muscles may not require as much weight as a simple fracture with little muscle damage. In a fracture in the same location, one should

not apply the same amount of weight to a one-hundred-pound girl as to a two-hundred-pound stevedore. The aim, in an early case, should be to restore the normal length of the extremity in not over six to twelve hours after traction is applied, and then to maintain it until union is obtained. Any extremity can be restored to its original length, after fracture, by traction methods, if union has not taken place. I have seen a fractured femur six weeks after injury with overriding and callus demonstrable by x-ray, pulled down to its original length by skeletal traction in forty-eight hours, without evidence of muscle damage. In a fresh case, if length has not been restored in twelve hours, either the wrong method of traction has been used or too little weight has been applied.

A common reason for failure to obtain restoration of length with traction is that adhesive plaster is used for fractures in which the weight that may be applied to it is insufficient to bring about reduction. In general, traction by adhesive plaster requires twice as much weight as skeletal traction to exert the same action on the bone. Fifteen pounds with skeletal traction applied over a number of weeks is common practice in a fractured femur. It would be a most exceptional case in which thirty pounds could be applied through adhesive plaster for a like period. Twenty-five to thirty pounds with skeletal traction is not unusual at the start of treatment of a fracture of the femur. One would not expect to be able to use fifty or sixty pounds with adhesive plaster. Some would use less; the distal fragment would not come down and the method of treatment, rather than one's surgical judgment, would receive the blame.

It is equally true that too little weight is often applied in skeletal traction. If overriding is still present after twelve hours, a small amount of weight is added; and, even then, one is surprised to find overriding still present after twenty-four hours. The fact has been forgotten that each added hour in which the muscles have been allowed to shorten requires a proportionately greater weight to overcome this shortening. The same lower leg which will return to its normal length with the application of ten pounds of traction immediately after the accident may require twenty pounds to do the same thing after twenty-four hours. If one keeps adding a pound or two of weight at intervals, one may be just behind nature in her shortening up of muscle and not obtain the desired length.

The error of insufficient traction appears just as frequently in another way. At the end of six hours it may be found by x-ray that the proper length has been obtained. The weight is then reduced too much at one time and the roentgenogram taken the next day shows marked angulation or overriding. I have seen a transverse fracture of the femur with overriding become a hair line with perfect apposition under sufficient traction, only to find, twenty-four hours later, that overriding had reappeared as a result of removing too much weight. More weight than on the first application is then necessary to bring the fragments back to the desired position. The principle is to apply sufficient weight to reduce over a short period, and lessen the weight gradually over a longer period.

When the patient complains of pain at the site of fracture, it almost invariably means that more weight is needed rather than less.

Overpull is not as common as insufficient traction, but the fear of it has probably kept more men from using this mode of treatment. It may be due to overenthusiasm with lack of experience, but more commonly to lack of frequent confirmation by x-ray. I have seen it occur apparently as a result of greater muscle injury than one suspected, so that less than the usual pull was required at the start. If overpull is present for more than a few hours, the extremity does not usually shorten on lessening the weight; the x-ray continues to show space between the fragments and union is delayed while this fills in with callus. I have not seen non-union occur under these circumstances. The moral is to check daily by roentgenographic examination while making any changes in the amount of weight, and then at least every five to seven days. The larger one's experience, the more seldom overpull occurs; it is a rare occurrence anyway, and the disability is no greater if the injured leg is one-quarter inch longer than if it is one-quarter inch shorter than the opposite side.

4. *The Use of Adhesive Plaster.*

Adhesive plaster is in common use as skin traction and works well within limitations. Zinc-oxid plaster should not be used, but a good grade of moleskin plaster. The part should be shaved, cleansed, and dried before its application. The plaster should start several inches above the site of fracture, unless that means crossing a joint. The theory that the plaster should start at the level of the site of fracture is a fallacy. In children under five years of age or of comparable size, overhead suspension by adhesive plaster for a fracture of the shaft of the femur gives excellent results. Both lower extremities must be suspended or one does not get the full benefit of body weight as countertraction, and rotation of the fragments is liable to occur. The weight should be such that the buttocks are at all times free from the bed. Adhesive-plaster traction is often the method of choice in fractures of the shaft of the femur between the ages of twelve and twenty, when traction may be necessary and skeletal traction is inadvisable because of possible interference with growth from insertion of tongs or pin near the epiphyseal line.

Skin traction is usually sufficient in intertrochanteric fractures. In the adult, its use should be discouraged in all other fractures of the shaft of the femur. The weight required is more than the skin will usually stand for the necessary time. As the plaster gradually comes away, blistering and denudation of skin is frequent, requiring delay before the reapplication of the plaster. In the upper third of the leg adhesive-plaster traction is usually sufficient, if any is needed. But in the lower two thirds of the leg it is insufficient, because, as with the femur, more weight is required than the area of skin will stand. In the upper extremity sufficient traction can usually be applied through adhesive plaster.

5. *Improper Apparatus or Improper Use of Apparatus.*

There are many types of tongs, pins, and wires which are good. Some have one advantage, others another; none is ideal. Better results are probably obtained by learning the use of one tong or pin thoroughly than by constantly changing as new ones are devised. Certain ones are absolutely to be avoided. One should not use the type of Steinmann pin which is made in two parts and screws together at the center. Such a pin is too weak. One was put in at our hospital by mistake a few years ago and it broke in the middle after a few days. Several months later an abscess developed in the center of the os calcis about a small piece of metal which had remained in. It is inadvisable to use tongs with long points. They are apt to pierce too far into the bone. We tried tongs in the malleoli for leg fractures for some time, but discarded this method several years ago, as the tongs were too prone to slip out. The Pierson leg piece is a necessary adjunct in skeletal traction on the femur or balanced traction on the leg, but it is rarely attached at the knee joint. One forgets that the joint is approximately opposite the tubercle of the tibia and the piece is usually seen attached much higher. The Pierson leg piece was devised so that movement at the knee joint might be kept up during treatment. Its use is all too often a matter of form only, as examination of the ropes, weights, and suspension of the splint will show that knee motion of more than five to ten degrees is an impossibility. With the proper application of apparatus, the patient must be instructed how to move the joint at regular intervals. If a full ring Thomas splint is used, care should be taken that it is large enough for comfort. Traction is not exerted against the tuber ischii in suspension treatment unless fixed traction is used. Ropes and pulleys should be attached so that traction is exerted in a straight line with suspension at ninety degrees. Otherwise, one cannot know what pull is actually being exerted and in what direction. Theoretically pressure pads seem useful, but in practice it is the exceptional case in which they actually improve position. Their place in relation to the site of fracture should always be controlled by x-ray.

6. *Nursing Care.*

Interested nursing, with understanding of what the surgeon is trying to do, is absolutely necessary. It is impracticable to attempt to have every nurse in a hospital care for fracture patients. A person who will pay constant attention to details is needed. The nurse must know when any change has occurred in the conditions of traction, and be taught to distinguish between those things which she may adjust herself and those which require the attention of the surgeon. If the patient is lying on a pelvic ring, the skin can be kept in perfect condition by seeing to it that the same area of skin does not continuously come in contact with the ring. Hammocks beneath an extremity in a splint must be kept taut so that the extremity lies on a flat surface level with the bars of the splint and not

in a gutter. The latter position favors angulation and changes the lines of force. To obviate it usually requires tightening the hammocks more than once a day. Most patients do not need to lie flat on the back constantly.

7. *Neglect of Combined Methods of Treatment.*

Methods of traction may and often do reduce displacements in fractures. But knowledge of this fact should not keep us from using manual reduction under anaesthesia in combination with it in certain cases, particularly in the early hours of treatment. This is attainable without removing the extremity from its suspension splints. Following the open reduction of a fracture, traction methods are often more advisable than plaster-of-Paris splinting. Coaptation splints will sometimes assist in preventing angulation in traction cases, particularly in humeral shaft fractures.

8. *The Use of the X-ray.*

It is questionable whether traction treatment should ever be used unless a portable x-ray outfit is available. Movement of the whole bed to the x-ray room in these cases is rarely satisfactory. It is necessary to have the fracture roentgenographed at least every twenty-four hours until the desired position and amount of weight are attained and maintained. After this there should be a roentgenographic examination at least weekly until firm union is present. Any change in weight applied requires reexamination by x-ray. Roentgenograms in two directions are necessary at all exposures. Lack of roentgenograms at sufficiently frequent intervals has jeopardized the result in many traction cases, just as it has in plaster cases. The presence or absence of callus as shown by the x-ray cannot always be used as a criterion for removing traction. Firm union may be present, while the roentgenogram still fails to show an appreciable amount of callus.

9. *Care of Wounds.*

In fractures compounded from the outside, proper surgical treatment of the wound is essential until the danger of infection has passed. However, traction sufficient to bring about the normal length of limb lessens the likelihood of infection by improving the circulation of blood and lymph and permitting the soft parts to resume their normal relations. In the care of wounds made by tongs and pins, dressings, when necessary, should be done with meticulous care by one person only.

10. *Physiotherapy.*

One of the reasons advanced for the advantage of traction treatment over plaster methods is that it is possible to apply local treatment to the part. Too often this is neglected for the first week or two, the only time when it is of any particular importance. Local heat should be given frequently after the first twelve hours. Superficial massage should be

commenced at least within twenty-four to forty-eight hours. By this method, plus elevation of the part, a few days at most suffice to remove most of the evidence of swelling in the limb. If the use of heat and massage is delayed for seven to ten days, a long period of time may be needed to remove the swelling and its results. Passive motion should be discarded, at least until firm union is obtained. On the other hand, guided active motion must be encouraged from the first, for active motion is far more important than all the other methods of physiotherapy combined. The patient should also be instructed to exercise his three remaining extremities and neck and back muscles regularly each day, in order that his general muscular tone may be preserved as much as possible.

11. *Removal of Traction.*

Traction should be continued until union is sufficiently firm to maintain the same position of the fragments after the weight is removed. It is preferable to maintain traction for too long a period than otherwise. If, after removal of traction, overriding of an oblique fracture, angulation, or fracture of callus occurs, a good result may be lost or the progress of healing set back many weeks, whereas traction for one or two weeks longer might have prevented this. If retentive apparatus is to be used following removal of traction, this should be ready before traction is removed and should be applied immediately. One must remember that in examining an extremity in suspension for the presence of union, even though all traction weight be removed, the part may still be somewhat immobilized by hammocks and ropes and one may be thus easily led into the belief that union has progressed further than is really the case. Examination for union must be in two directions and the result should be concurred in by two surgeons.

CONCLUSIONS

The number and variety of the points cited above may make traction-suspension treatment sound formidable. Experience has shown that these must be frequently recalled in order to obtain the desired results. Watchful care is the main requirement. Traction-suspension treatment, with due regard for the above mentioned factors, is the method of choice in many patients to restore length, axis, and function of a fractured extremity with the maximum of comfort and safety.

1. Findlay, Robert T.: First Aid for Fractures. J. Bone and Joint Surg., XIII, 701, October, 1931.

THE TREATMENT OF COMPOUND FRACTURES

A Specific Technique for the Prevention and Control of Osteomyelitis*

BY FRASER B. GURD, B.A., M.D., C.M., F.R.C.S.(C.), F.A.C.S.,
MONTREAL, CANADA

From the Montreal General Hospital

During the Winter of 1917–18, due to the interest of Sir Robert Jones, the writer had the opportunity of undertaking an experimental study on wounded soldiers suffering from infected compound fractures. The results of this study were published in 1918 [1].

Since the beginning of 1919, when the author returned to the treatment of civilian injuries, a definite technique [2] for the treatment of severe compound fractures has been employed. During this time only trivial modifications of the procedures, adopted immediately following the War, have been made. As the result of the treatment of a large number of cases during this period by himself and his immediate associates (Dr. L. H. McKim and Dr. George D. Little), and by comparison of these results with cases treated by other techniques in different clinics, the author is convinced that the results obtained by this method of treatment have, in the long run, been more favorable.

For the prevention and elimination of infection and cellulitis, we employ a technique, in the hope that the following *desiderata* may be obtained:

I. Avoidance of Suitable Pabulum for Bacterial Growth.
   - A. Excision of devitalized tissue.
   - B. Prevention of accumulation of inert exudate and blood. (See II, A, 2.)

II. Maintenance of Circulation.
   - A. Avoidance of interstitial tension.
     1. Incision of skin and fascia.
     2. Evacuation of exudate and transudate.
        - a. Obliteration of dead spaces.
        - b. Curtain drainage.
     3. Prevention of adhesion of opposing wound surfaces,—delay in sealing of wound. (See II, A, 2, b.)
   - B. Rest,—fixation.
     1. Plaster-of-Paris.
     2. Splints.
     3. Traction.
   - C. Posture,—gravity to assist venous and lymphatic drainage.

* Presented by invitation at the Annual Meeting of the American Orthopaedic Association, Toronto, Canada, June 17, 1932.

III. Chemical Inhibition of Bacterial Growth.
  A. Saprophytic bacteria.
    1. Iodoform.
    2. Bismuth.
  B. Pathogenic bacteria.
    1. Iodoform.
    2. Bismuth.
IV. Stimulation of Tissue Reaction—Serous and Cellular.
  A. Iodoform.
  B. Bismuth.
  C. Liquid Paraffin.

Since the majority of cases of compound injuries occur in fractures about the junction of the middle and lower thirds of the leg, the treatment of compound fractures of both bones in this neighborhood, with severe laceration of the skin and tissues, will be considered in some detail.

TABLE I

FRACTURES OF SHAFTS OF BOTH BONES OF LEG—1926 TO 1931—CENTRAL AND WESTERN DIVISIONS—MONTREAL GENERAL HOSPITAL

Author's Service Only

Total no. of cases	Simple	Compound, Group I—puncture wounds	Compound, Group II—lacerated wounds	Amputations, primary	Amputations, secondary	Died
307	220	24*	47**	13***	4****	3*****

* Many cases in Group I are not traceable, as such, and are included as simple fractures.
** Includes cases of secondary amputations but not of primary amputations or deaths.
*** Includes nine cases due to wheels of trams or railroad carriages, one due to wheels of fire engine, two due to motorcycle crashes, and one following jump out of fourth story window.
**** Includes three cases of dry gangrene and one case of gas gangrene.
***** Includes two cases of death within ten hours from shock, and one case of death on the third day from delirium tremens. Other patients with multiple injuries died within a few hours, untreated with reference to leg, and are not included here.

It is not my purpose in this contribution to discuss the treatment of shock *per se*. With as little delay as possible, the patient is taken to the operating room. The author is convinced that it is always advisable to treat the mutilated extremity at the same time as the more important resuscitative measures are being carried out, rather than that time be spent in overcoming shock prior to the initiation of operative measures.

Under gas-oxygen anaesthesia (with or without the assistance of avertin basal anaesthesia), the preliminary splinting is taken off and, unless the clothing has been removed immediately following injury, this is also cut away. The employment of novocain or avertin to fortify the effects of the gas and oxygen may, in certain cases, be necessary and is often helpful.

Too much stress cannot be laid upon the general toilet of the ex-

tremity, more particularly in the employment of soap and water cleansing and careful shaving of the skin. The limb in the neighborhood of the injury, and the wound itself, are then generously cleansed with petrolic ether and the whole surface dried before the use of alcohol. Although by no means convinced that iodin is of greater value than the other skin antiseptics, in view of the fact that iodin in the molecule of iodoform is to be used later in the treatment of the case, the author has felt it advisable to rely upon this substance for skin sterilization in traumatic emergencies. Moreover, there is no reason for avoiding the introduction of tincture of iodin into the wound itself.

The first stage in the operative interference consists of the excision of the narrowest possible edge of the contaminated and crushed skin. The skin wound is then enlarged in such a way that complete exposure of the underlying structures is brought about. Although enlargement of the wound is, in part, made in order that exposure of the deep structures may be adequate, the more important reason for incision is in order to anticipate interstitial tension which, it must always be assumed, is likely to take place during the first few days following injury. Adequate skin incision having been accomplished, the deep fascia is split well beyond the zone in which it is thought probable that inflammatory oedema of the tissues may occur. All obviously contaminated muscle and fascial tissue is excised, together with such muscle masses as appear to have been devitalized by crushing. Incompletely separated bone fragments, whether large or small, which show any attachment to any tissue whatever are allowed to remain in place. The surface of grossly contaminated fragments is removed by means of the rongeur.

At this stage of the operation all grossly contaminated and crushed tissue has been removed, all bleeding points have been clamped and certain of them ligated. A large surface wound has been made and, in so far as possible, the wound has been rendered saucer-shaped or funnel-shaped in appearance. Fractured bone ends have been brought under adequate vision. If nerve injury has occurred, as careful suture as is possible under the circumstances has been accomplished, and torn tendon ends have been approximated.

The whole wound is then thoroughly washed with normal saline solution on large sponges. The surface of the wound is then dried and thoroughly bathed with alcohol, in order that the surface tissues may be dehydrated. With dry sponges the alcohol is then removed and bipp * [1] rubbed on to the surface, all excess of the paste being removed. Particular care must be paid, in the bipping of the wound, to reach all the interstices of the tissues and particularly to cover the bone fragments. The properly bipped wound will show a slightly yellowish gray film overlying all the tissues, but nowhere should yellow masses be visible.

* Bismuth, iodoform, paraffin paste containing bismuth subnitrate 1 part, powdered iodoform 2 parts, and liquid paraffin about 1 part, or sufficient to make a thick paste. It is of the utmost importance that vaselin or paraffinum molle should not be used, as with such a vehicle an ointment which will not adhere to the raw surface results.

The wound being bipped, wide (two to four inch) soft packing gauze is soaked in liquid paraffin and a small amount of bipp * is rubbed into it. This liquid paraffin-soaked, bipped gauze is firmly and carefully packed into the wound, the greatest care being taken to fill all crevices and small cavities in the deeper parts of the wound. In order that the packing may be held firmly in place, and in order that the skin edges may not retract unduly, a few silkworm gut sutures are employed to partially approximate the skin edges without tension. The whole pack is thus, more or less completely, buried within the limb.

At the commencement of operation, traction is exerted upon the limb, either by means of a Delbet sling on the foot, or by means of skeletal traction through the os calcis or the lower part of the tibia and fibula. At the completion of the operation a thin layer of padding is applied to the limb from the toes to about the junction of the middle and upper thirds of the thigh and a circular plaster-of-Paris bandage applied. Antitetanic serum is administered ** and whatever resuscitative measures have been indicated are continued.

The patient is returned to bed and the foot of the latter raised about eight inches, in order that blood and lymph stasis in the injured extremity may be limited. During the first few days following operation, it is to be expected that the plaster will become discolored, in consequence of the exudation of blood and serum. The temperature chart is watched, and only if the temperature remains above 103 degrees is the plaster interfered with; upon no account should a window be cut. If it be deemed absolutely necessary to examine the limb—which it may be added is very rarely the case—the whole anterior half of the plaster should be removed.

TABLE II

Compound Fracture, Lacerated Wounds, Both Bones of Leg

Total no. of cases	Average age	Average days in hospital	Average days between operation and first dressing	Average*** days before union	Secondary amputation	Non-union	Delayed union	Secondary removal of dead bone
47	29	53.90	18.63	66.5	4	0	4	4

*** Excluding delayed cases. Indicates clinical union, but not necessarily considered fit for unprotected weight-bearing.

The position of the bones is immediately checked by x-ray examination. Although the presence of bipp in the wound and in the packing results in a shadow, only rarely is the picture so obscured that an adequate idea of the position of the bone fragments cannot be obtained. Unless very marked deformities are seen in the x-ray examination, further interference with the limb should not be carried out before the lapse of, at

* The maximum quantity of bipp employed should not, I believe, exceed fifteen cubic centimeters.

** In very severe crushing injuries, polyvalent antigangrene serum is probably useful and is recommended.

least, ten days following injury. As a rule, the first dressing is carried out about three weeks after the primary interference, at which time a certain definite stability of the limb is usually noted.

FIG. 1

Roentgenogram showing liquid paraffin-soaked, bipped pack in position. Case J. V., twenty-four years of age.—No. W–549–27. Severe compound fracture of both bones. Plastic operation three weeks after injury. Healed and union sound within three months.

FIG. 2

Roentgenogram showing bipped, paraffined, gauze pack in position. Case W. E., twenty-five years of age.—No. 4426–30. Severe compound fracture of both bones. Wound soundly healed and bones firmly united within six months.

The first dressing is carried out in the operating room; it is advisable to employ for this purpose either general (nitrous oxid and oxygen), avertin, or spinal anaesthesia.

FIG. 3
Same case as shown in Fig. 2.

In order that displacement of the bone ends may not take place, a Delbet sling is applied to the foot and traction employed during the course of this interference. The sutures are removed and the whole wound thus opened up. The pack is carefully removed so as to avoid, in so far as

possible, injury to the surface tissues with consequent bleeding. As a rule, examination of the wound at this time (eighteen days following injury, more or less) shows it to be covered with firm deep red granulations, both in so far as the soft tissues are concerned and also the exposed bone. Bone fragments, which at this stage are completely devoid of granulations, should be removed.

If packing has been adequately carried out, so that no dead spaces have been present in the tissues, no purulent exudate will be found. If small areas of devitalized tissue have been overlooked at the time of the original interference, these tissue masses will, for the most part, have come away with the removal of the pack, and those remaining in the wound are removed by swabbing or blunt dissection. After hemostasis has been accomplished, by means of hot saline packs, the whole wound is mopped with alcohol and dried. Bipp is then carefully rubbed into the surface of the whole wound and the cavity again repacked with liquid paraffined gauze with a small amount of bipp added. As a rule, the amount of gauze which the wound will hold at the first dressing is approximately one-half of that which was found necessary at the original operation. Plaster-of-Paris, with a thin layer of padding underlying it, is again applied as a circular cast.

Depending upon the primary severity of the wound and the conditions as noted at operation, the period between the first and second dressings will vary. As a rule, approximately three weeks may be profitably allowed to elapse at this stage. It is usually advisable to employ anaesthesia for this dressing also, in order that adequate exposure of the depth of the wound may be carried out. Again a complete search for white bone fragments is made and loose pieces of necrotic bone removed. If suture of the superficial parts, including skin, will result in obliteration of dead space, such a procedure is carried out, after having carefully bipped the wound. If a dead space is unavoidable, this is again repacked and the wound partially sutured. At the second dressing moderately firm fixation of the fracture will usually be found to have taken place. As a rule, therefore, it is advisable at this time to apply a circular cast without padding, in order that the patient may commence weight-bearing [4].

Dressings, subsequent to the second, will rarely require an anaesthetic, unless it be decided that time will be saved by secondary suture of the wound, or, as not infrequently happens, it may be judged advisable, in the presence of a large area over which normal skin has been lost over the anterior surface of the leg, to perform a plastic operation.

The interval between subsequent dressings will usually be from three to four weeks. Once moderate consolidation has taken place, the long plaster cast is replaced by a short apparatus of the Delbet type, in order that knee, foot, and ankle function may be reestablished.

In our experience, the presence of bipp in the wound or about the bone ends has not been the cause of delayed union or non-union. This fact was early established by Rutherford Morison [3].

The author has previously expressed [2] the opinion that if more than 144 square inches of tissue are exposed to the action of bipp, definite evidence of poisoning, either iodoform or bismuth or both, may occur. If, however, the wounds be less in size than one square foot, the danger of any important injury to the patient arising from either of these drugs is, in the author's opinion, negligible; granted, of course, that the proper technique be used in its employment. The presence of a blue-black line on the gums is not, in itself, of any great importance, but should be interpreted as a sign. The presence of a marked stomatitis, with involvement of the buccal mucosa or the floor of the mouth, is, of course, to be avoided, and should be prevented in the individual case by the removal of all or most of the bipp at the first sign of tenderness of the teeth.

The development of a colitis with the exhibition of the usual symptoms of this disease is a serious matter. As stated above, however, such a complication is avoidable, nor has it occurred in any case seen by the author since his return to civilian practice. As a general statement, it may be said that since return to ordinary surgical work, and notwithstanding the fact that bipp has been employed as an adjuvant in the treatment of both abdominal [5,6,7] and thoracic [8] suppuration to a very considerable degree, the author has not seen a case manifesting either iodoform or bismuth poisoning of a grade sufficient to cause any anxiety whatever.

Although by means of the technique suggested in this contribution, phlegmonous inflammation in even severe compound fractures is almost completely eliminated, the author's experience during the War and with a limited number of cases in civilian practice, in which, prior to the cases coming under his personal observation, diffuse cellulitis and tissue necrosis had already occurred, has proven that the technique herein recommended is of value. Approximately the same method has been employed in the treatment of acute infective osteomyelitis with satisfactory results.

Essential features of the technique as applied to cases of bone infection, in which marked inflammatory changes are already present, are: incision of the tissues beyond the site of manifest inflammatory changes; adequate exposure of all suppurative loculi and interstices in the tissues; careful and complete removal of all dead or devitalized tissue; proper bipping of the whole wound and careful packing with liquid paraffin-soaked, bipped gauze. The packing is introduced in such a way that all deep-seated cavities are brought into communication with the surface. In practice, such a method of treatment results in lessening of pain and discomfort on the part of the patient; the number of dressings required is materially reduced; and, since it is recommended that the majority of dressings be carried out under an anaesthetic, there is less suffering on the part of the patient and more adequate treatment of the wound.

SUMMARY

In the treatment of severe compound fractures with extensive lacera-

tion and contamination of tissue, a specific technique is recommended. This method, which is essentially a modification of the procedure suggested by Rutherford Morison in 1916, is based upon the results obtained in the study of severe cases, already infected, observed at Alder Hey Military Orthopaedic Hospital during 1918. Since the War, the method has been more especially adapted to the prevention of infection and inflammation in civilian injuries.

The essential features of the technique recommended are:

1. Immediate operative interference and reduction of fracture, *secundum artem*.
2. Conservative excision and radical incision of tissues.
3. Proper bipping of the wound following dehydration.
4. Obliteration of dead spaces and prevention of adhesion of opposing wound surfaces by means of firm packing with relatively large, liquid paraffin-soaked, bipped packs.
5. Avoidance, in so far as possible, of ligatures and sutures.
6. Application of plaster-of-Paris over a thin layer of padding; no window.
7. Infrequent dressings,—the first approximately eighteen days after injury, done in the operating room under an anaesthetic; a secondary suture used and packing as indicated.
8. As soon as union commences, the application of an unpadded plaster and felt heel.

REFERENCES

1. Gurd, F. B.: A Contribution to the Technique of Infected Wound Closure, More Especially Compound Fractures. Lancet, I, 731, 1918.
2. Gurd, F. B.: The Application of Rutherford Morison's Technique of Wound Treatment to Civic Surgery. Canadian Med. Assn. J., IX, 625, 1919.
3. Morison, Rutherford: Bipp Treatment of War Wounds. Oxford War Primers. London, Frowde, Hodder and Stoughton, 1918.
4. Gurd, F. B.: Treatment of Fractures Involving the Ankle-Joint; With Special Reference to the Use of the Pillow Splint and Early Weight-Bearing. Ann. Surg., LXXXVIII, 260, 1928.
5. Gurd, F. B.: Appendectomy for Acute Perforated Appendicitis with Special Reference to the Prevention of Wound Infection. Am. J. Surg., VII, 266, 1929.
6. Gurd, F. B.: A Specific Technique for the Treatment of Acute Perforated Appendicitis. Am. J. Surg., XVII, 52, 1932.
7. Gurd, F. B.: The Operative Treatment of Acute Appendicitis with Perforation. Canadian Med. Assn. J., XXVII, 360, 1932.
8. Gurd, F. B.: The Surgical Treatment of Chronic Infected Open Pneumothorax. Canadian Med. Assn. J., XI, 408, 1921.

SPLENIC EXTRACT TREATMENT OF BONE AND JOINT TUBERCULOSIS *

BY THOMAS F. WHEELDON, A.M., M.D., F.A.C.S., RICHMOND, VIRGINIA

INTRODUCTION

The treatment of bone and joint tuberculosis, considered ideal by almost everyone, is not always, nor even usually, possible in these parts. The state is large; the population is scattered; hospitalization for the large number of sufferers is out of the question; and education of the laity in many orthopaedic matters is not advanced. As a result, when the very strict discipline of approved treatment is suggested, the patient or his family is often accustomed to fly to others where he feels measures of a less

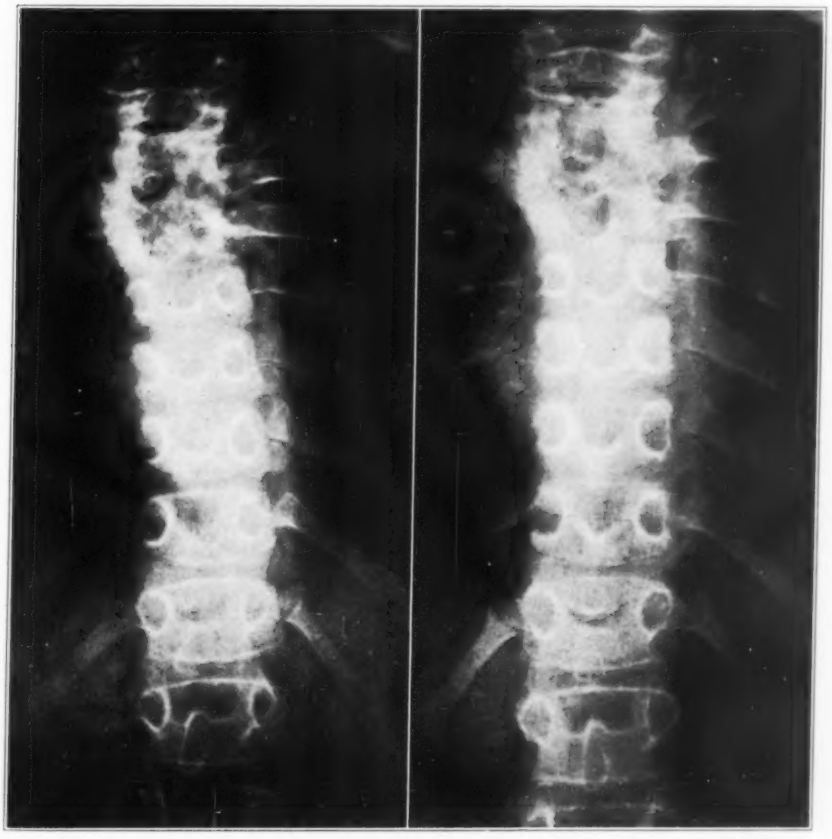

FIG. 1

Case 1 (F. B. 13092)
Left, before treatment. Right, after treatment.

* Submitted for publication, August 8, 1932.

FIG. 2

Case 1 (F. B. 13092)
Left, before treatment. Right, after treatment.

rigid character will be instituted. The writer has in mind a boy who had been under his care for several years for tuberculosis of the knee. The family was well pleased with his progress, but later, when he developed tuberculosis of the spine and absolute recumbency in a plaster shell was recommended, the parents unceremoniously took him to another who applied a light back brace and allowed full activity. The family have found their mistake too late.

For years, then, the writer has felt that an adjuvant which might hasten healing would be a God-send. When Otto Fliegel's article appeared in the fall of 1930, it seemed as if something definite had been offered. The writer's interest was immediately aroused (and so was the interest of many others as has been shown by personal communications, although, so far as can be learned, no definite problem has been attacked elsewhere) and at once he set to work to see what could be done to institute this treatment (raw calf-milt diet) in his own practice. This was soon found to be impracticable, and for three reasons: First, to secure and deliver regularly to the patients, scattered over a radius of at least two hundred miles, spleens in a state so fresh as to assure palatability is impossible. Second, to educate the patients so well that one can be certain that such spleens are eaten regularly is out of the question. Third, a

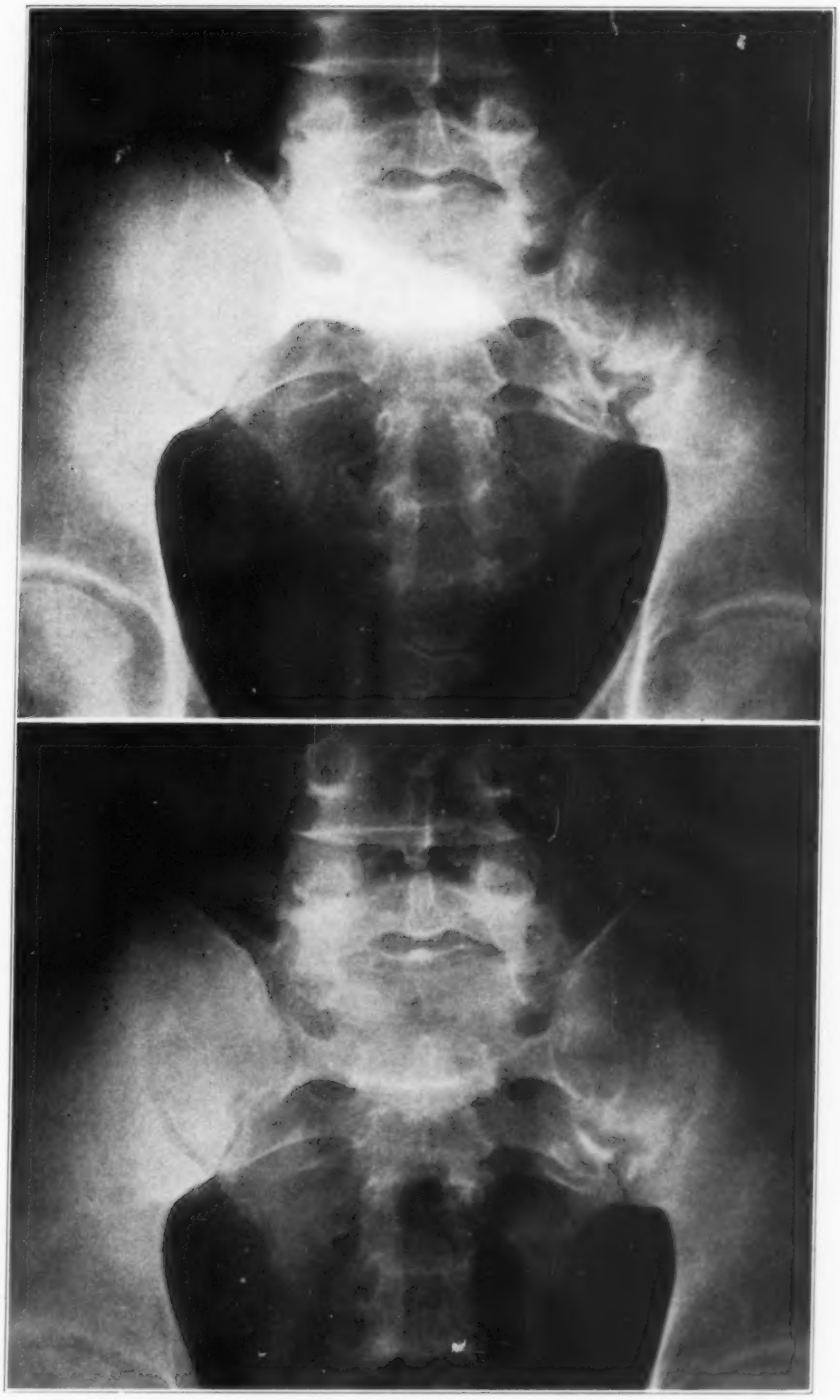

FIG. 3
Case 2 (P. B. 15434)
Above, before treatment. Below, after treatment.

supply of spleens is not available, as only by the purchase of futures can demand for this splenic extract be supplied.

Some other means of administration of the spleen had to be worked out, and it occurred to the writer that an extract of spleen might be made and used. This has been done.

METHOD OF PREPARATION

The spleens are purchased in large quantities, at the rate of about five thousand pounds a month at present, and are shipped frozen. After they are thawed out, the spleens are extracted with water, the coagulable proteins and fibers removed, and the aqueous fraction evaporated to a paste *in vacuo*. The consistency of this paste is that of thick condensed soup. One ounce of this aqueous extract (designated as S.V. 2) represents the water-soluble substances from approximately one pound of raw spleen. The preliminary biochemical analysis of this aqueous extract (S.V. 2) is found in Table I.

In addition to the aqueous extract (S.V. 2) other preparations have been made and tried,—*i.e.*, dried whole spleens (S.V. 1), and the dried residue (S.V. 3) remaining after the aqueous extract (S.V. 2) had been removed. A later paper will probably describe this work. Suffice it to say that no better results have been gotten from the dried whole spleen (S.V. 1) than from the aqueous extract (S.V. 2). The use of the dried

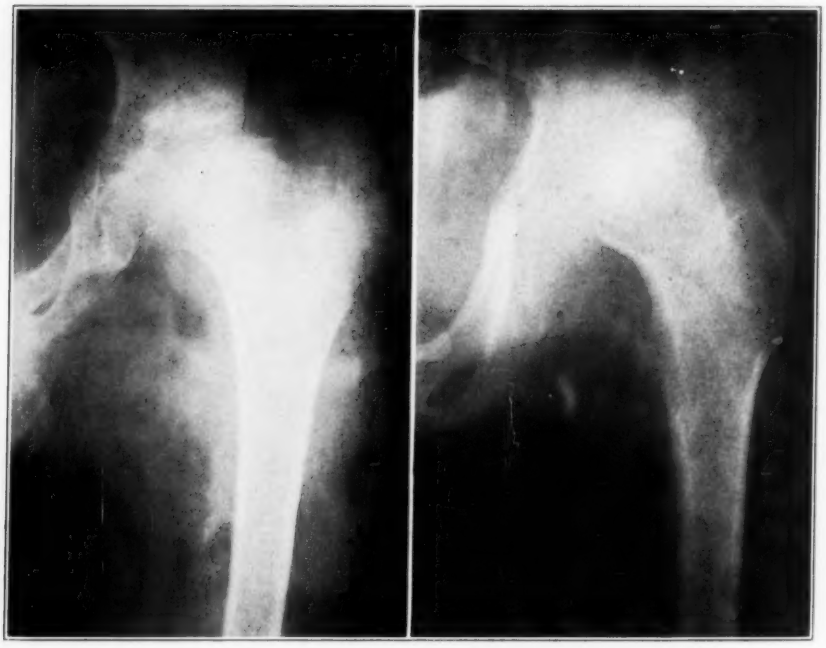

FIG. 4

Case 3 (L. E. C. 14078)
Left, before treatment. Right, after treatment.

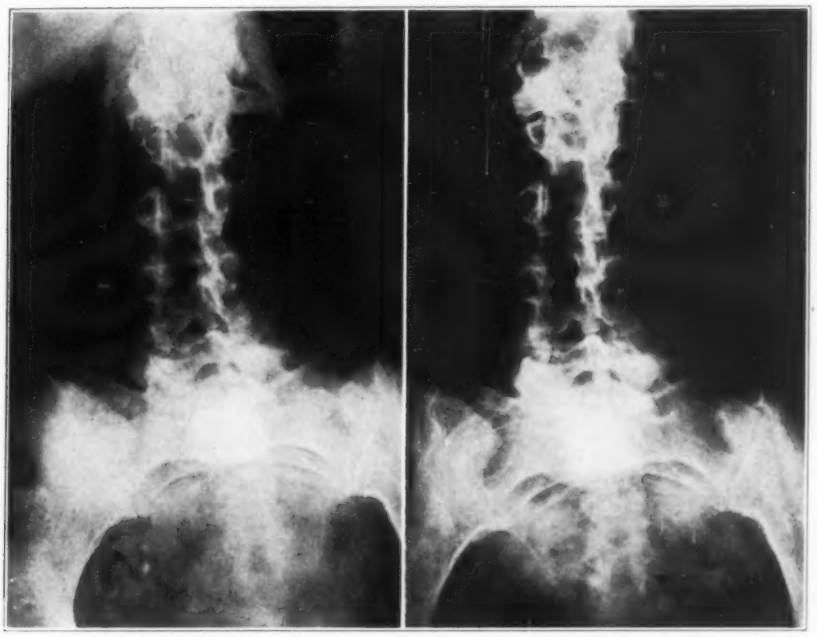

FIG. 5
Case 4 (M. F. 14778)
Left, before treatment. Right, after treatment.

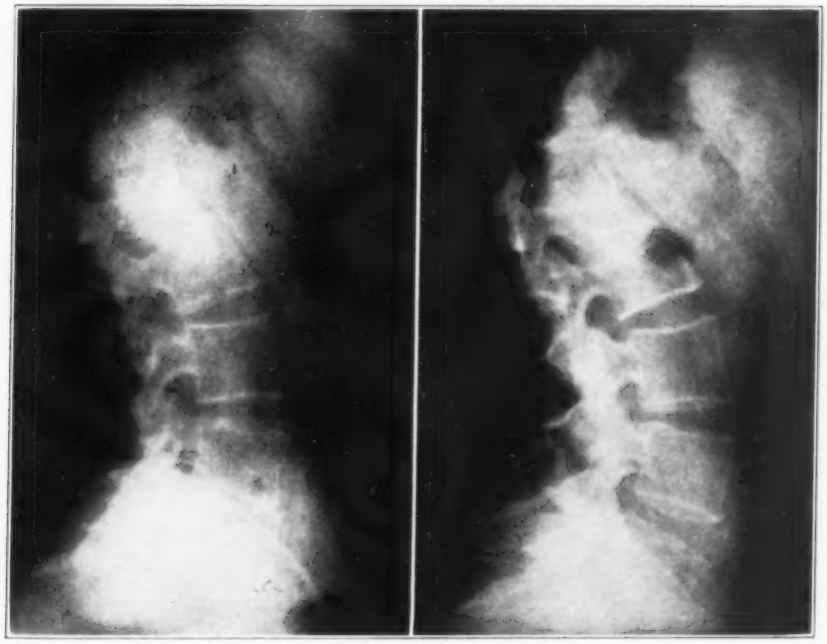

FIG. 6
Case 4 (M. F. 14778)
Left, before treatment. Right, after treatment.

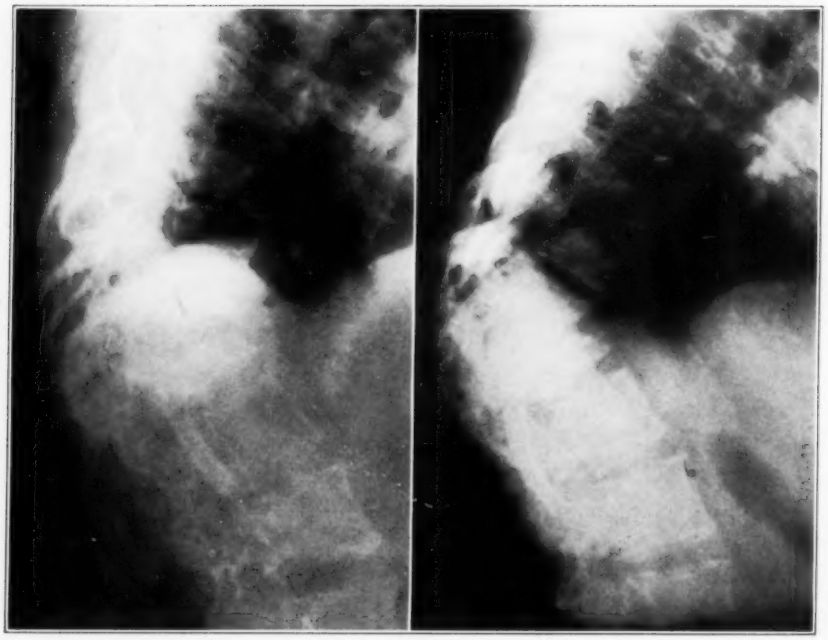

FIG. 7
Case 5 (P. F. 13386)
Left, before treatment. Right, after treatment.

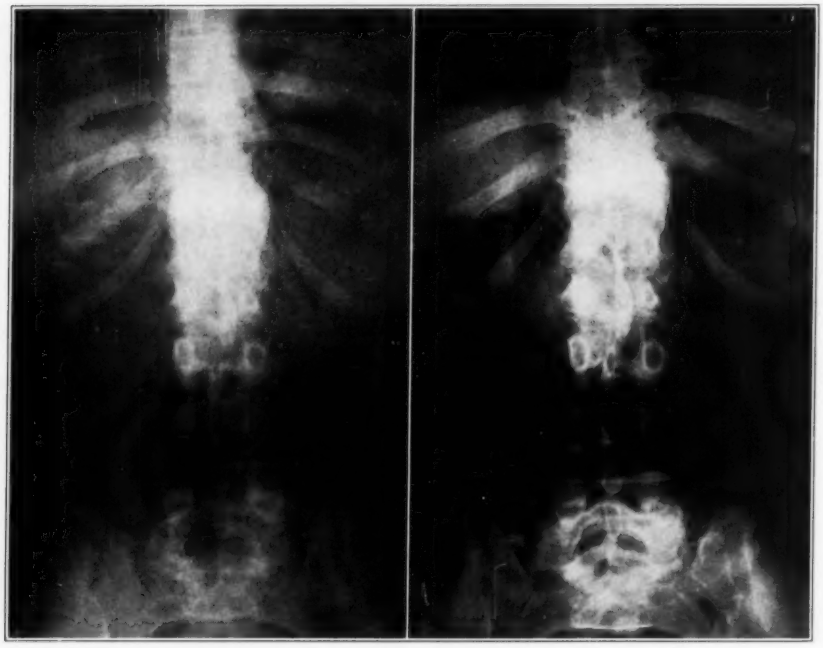

FIG. 8
Case 5 (P. F. 13386)
Left, before treatment. Right, after treatment.

FIG. 9
Case 6 (V. F. 16248)
Left, before treatment. Right, after treatment.

residue (S.V. 3) has not given enough encouragement to justify its continuance. The above leads to the belief that all or most of the active principle is to be found in the aqueous extract (S.V. 2), and the present paper deals with results obtained from this.

METHOD OF ADMINISTRATION

The aqueous extract of spleen (S.V. 2) is administered orally. The usual dosage is as follows:

The patient is given a teaspoonful three times a day for a week, or until it is found that he can and will tolerate the material. After that a tablespoonful is given three times a day. This dosage contains the active principle from one and one-half pounds of raw spleen. (Otto Fliegel administered only one and a half to three and a half ounces daily.) The dosage has not been varied, as very small children do not seem to have shown any ill effects and the dose seemed large enough for adults. Later it is expected that some quantitative work on this phase will be done.

The extract (S.V. 2) is best given in a sandwich, as hot bouillon, in tomato or orange juice, or as gravy. The use in gravy is probably the

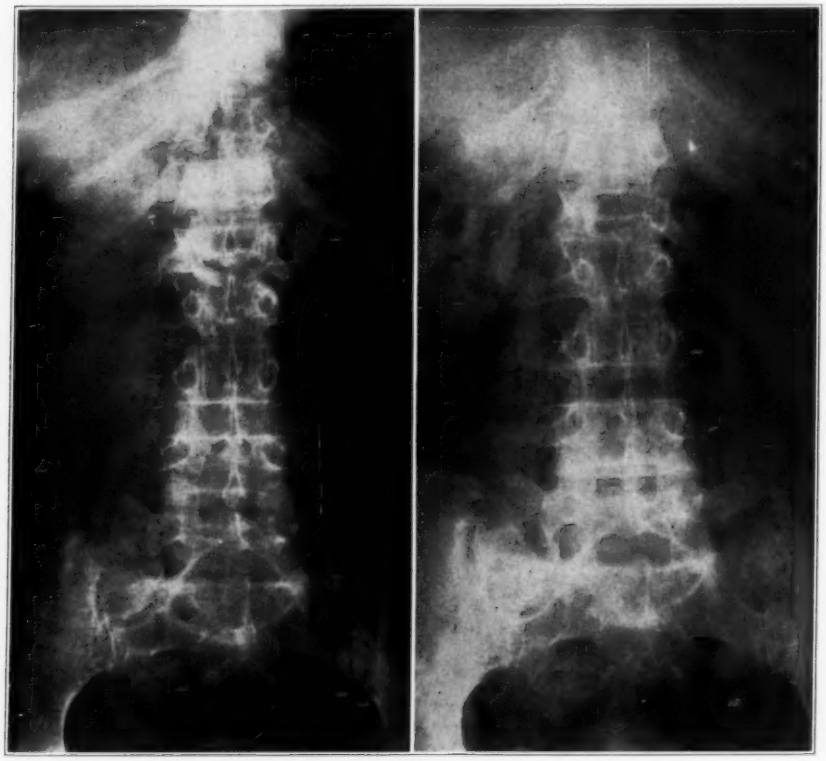

FIG. 10

Case 7 (R. H. 12244)
Left, before treatment. Right, after treatment.

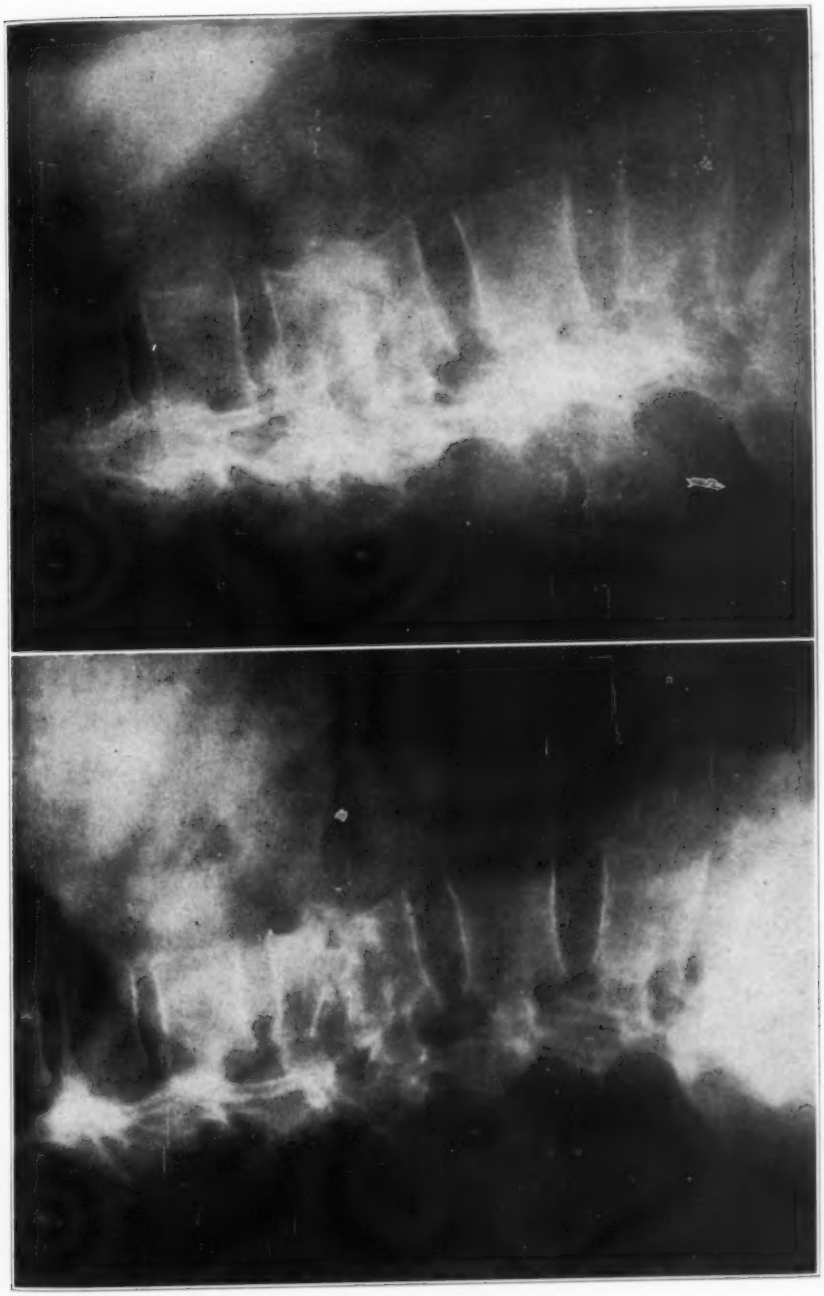

FIG. 11
Case 7 (R. H. 12244)
Left, before treatment. Right, after treatment.

FIG. 12
Case 8 (R. H. 7468)
Left, before treatment. Right, after treatment.

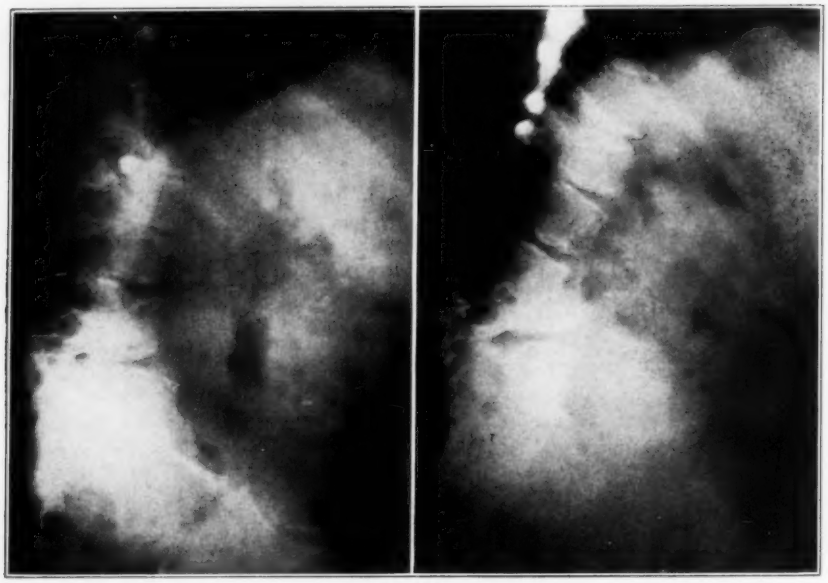

FIG. 13
Case 9 (T. K. 14590)
Left, before treatment. Right, after treatment.

FIG. 14
Case 10 (R. McF. 17241)
Above, before treatment. Below, after treatment.

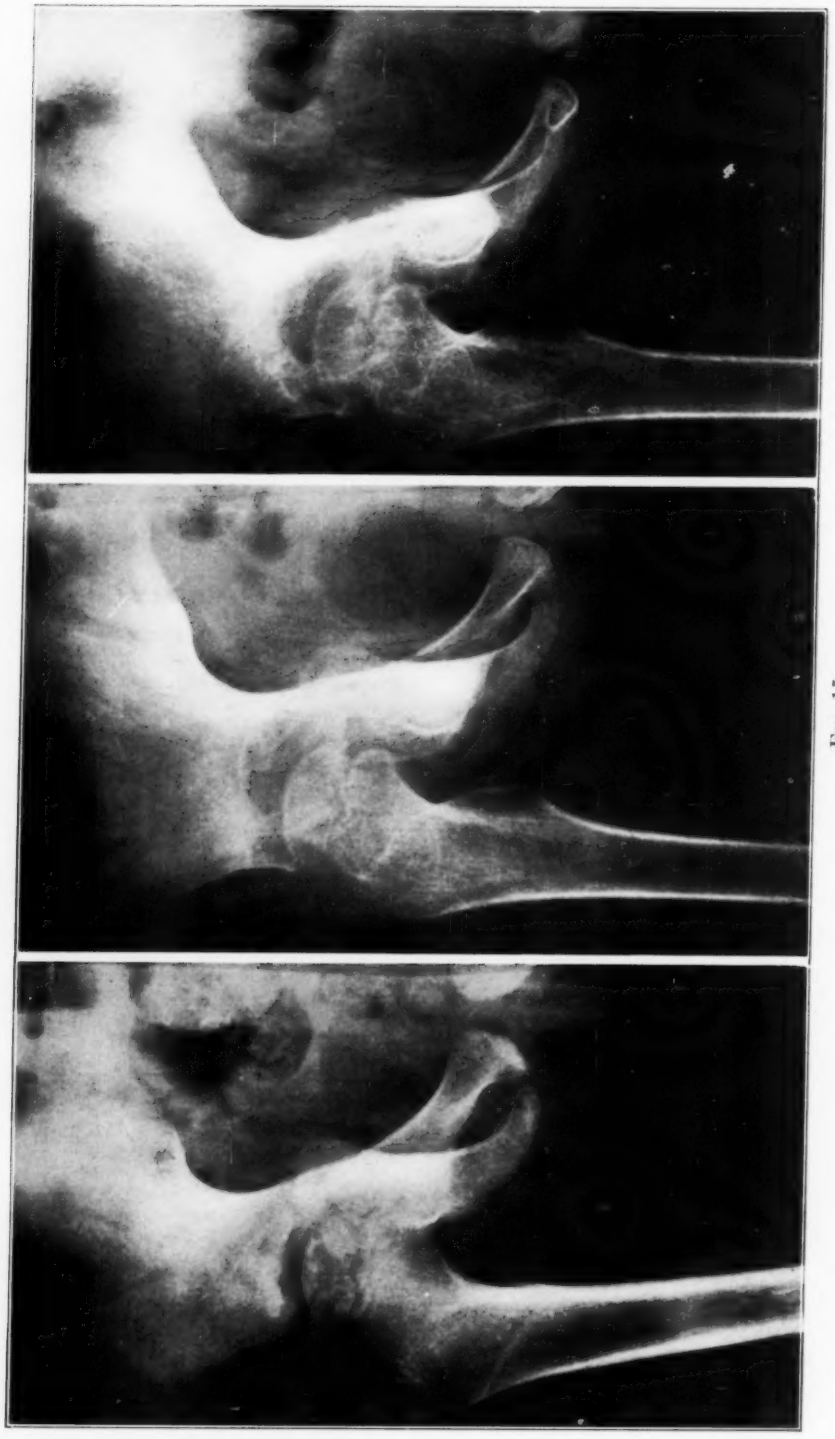

Fig. 15

Case 11 (C. P. 15300)

Left, before treatment. Center, during treatment. Right, after treatment.

most practicable. The taste is pleasanter than the odor. The person preparing the material for administration is, therefore, instructed not to let the patient smell it. A few patients have been troubled by vomiting. This has usually accompanied the actual ingestion of the extract (S.V. 2), but, in a small number of cases, has followed in one-half to one hour where actual ingestion has been accomplished without unpleasantness. The successful administration has been gained eventually in all these patients by reducing the amount or changing the vehicle for a while. No single patient has been found unable eventually to tolerate the diet. (The dietary phase also is being worked on at this time.)

The first cases were put upon the aqueous extract (S.V. 2) February 16, 1931, and the administration of the material has been continued without interruption except during short intervals due to various conditions,—*i.e.*, trouble in distribution of product, intervening acute illness, social problems, at times actual inability to secure spleens, etc.

These cases will be kept upon the material continuously so long as they improve or so long as lack of improvement can be explained. A series of cases will soon be started upon periods of interval administration.

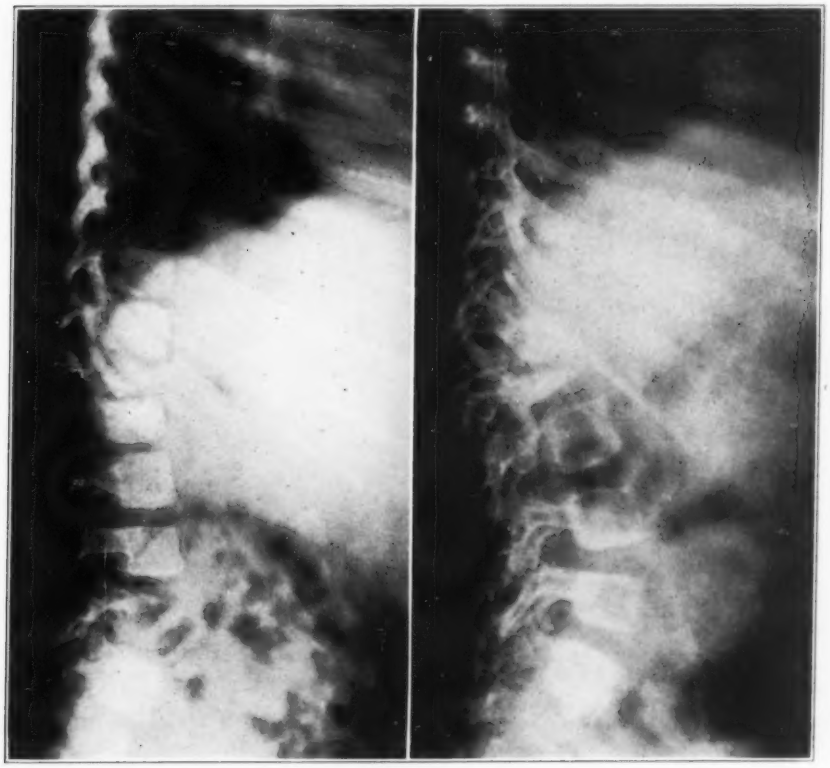

FIG. 16

Case 12 (D. F. 15755)
Left, before treatment. Right, after treatment.

This has not been done before because of a desire to get as much material as possible for the first paper.

GENERAL STATEMENT

At the present time the writer has on the splenic extract treatment (s.e.t.) over eighty cases in which it is thought a diagnosis of bone and joint tuberculosis can be safely made. In the present paper the results of splenic extract treatment (s.e.t.) of seventeen cases are considered. These seventeen cases were available when the first supply of aqueous extract (S.V. 2) was delivered. As this first supply was naturally limited in production, these cases were specially chosen to use the extract; they were chosen either because *they had not done well by treatment up until that time* (February 16, 1931) or because they *were so severely involved that improvement could be quickly ascertained.* As production of the aqueous extract (S.V. 2) has been increased, the number of patients to whom it is administered has been increased, so that at this time (May 1, 1932) all the writer's cases of bone and joint tuberculosis are receiving it.

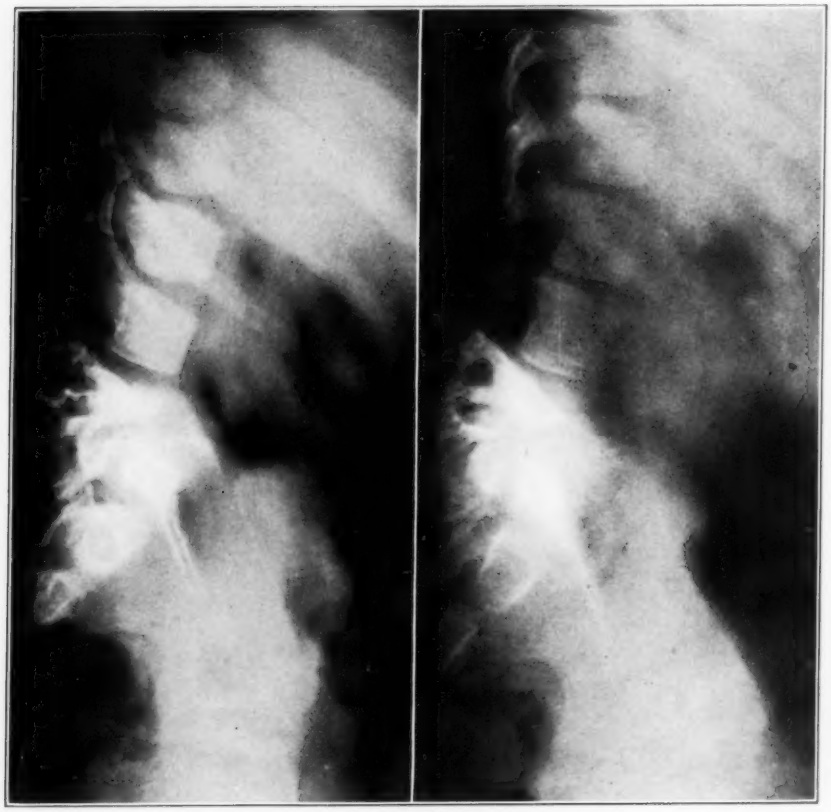

FIG. 17
Case 13 (H. R. 9682)
Left, before treatment. Right, after treatment.

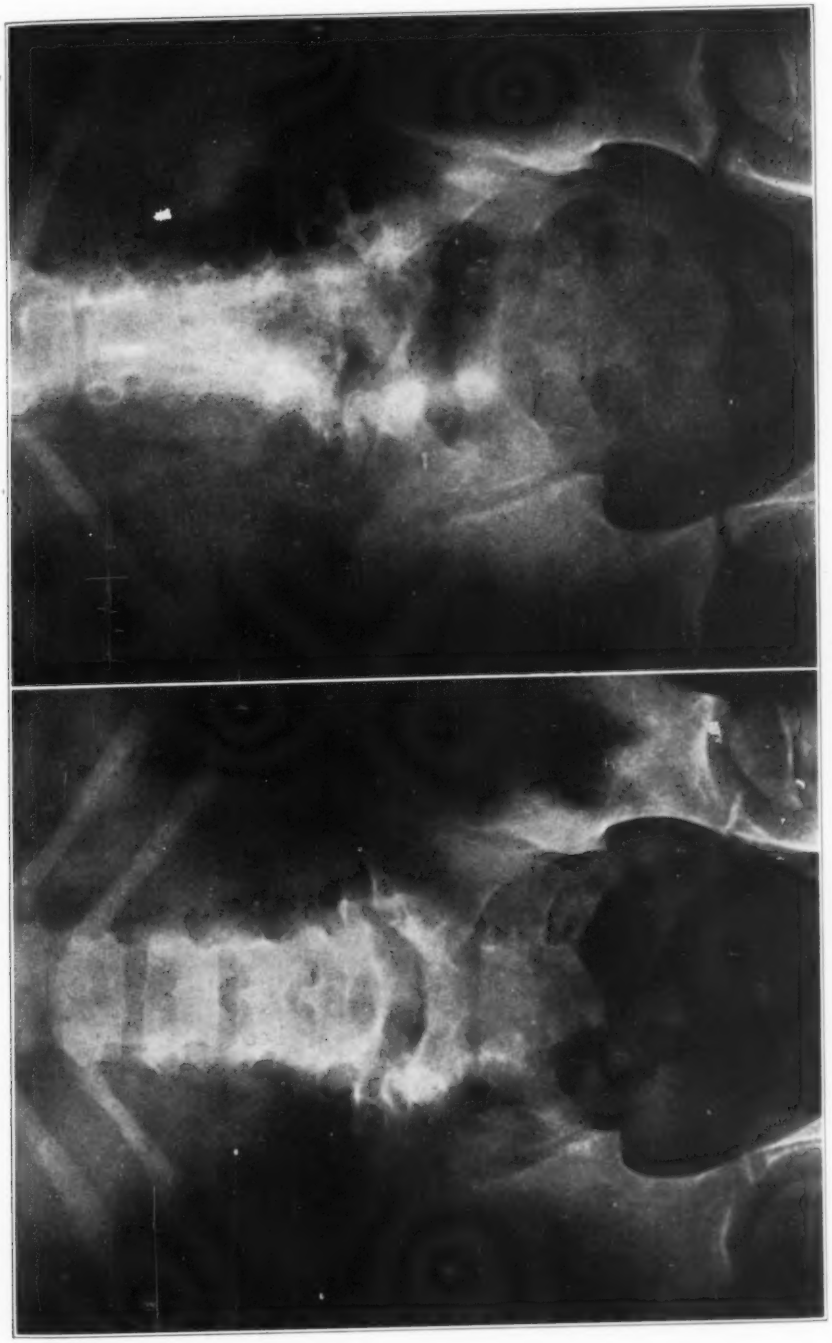

FIG. 18

Case 13 (H. R. 9682)

Left, before treatment. Right, after treatment.

TABLE I

PRELIMINARY BIOCHEMICAL ANALYSIS OF SPLENIC EXTRACT

	Per Cent. of Wet Weight	*Nitrogen, as Per Cent. of Total Nitrogen*	*Per Cent. of Ash*
Moisture (95° C.)	47.20		
Ash	9.94		
Chlorides, as NaCl	2.38		24.00
Phosphorus, as P_2O_5	2.52		25.40
Calcium, as CaO	0.06		0.60
Total Nitrogen	6.65		
Water-Insoluble Protein	17.80	42.90	
Coagulable Protein	0.73	1.76	
Proteose	1.59	3.82	
Nitrogen as Ammonia, Peptides and Extractives		51.50	
Ether extract (crude fat, etc.), not over	0.40		
Carbohydrates	Too low for quantitative estimation.		

One ounce of splenic extract yields about thirty-two calories

Experience with the splenic extract treatment, using the aqueous extract of spleen (S.V. 2), has been so encouraging that the writer wishes to describe the results in the seventeen cases which have been under treatment now for over a year, *expressing only the hope* that there may have been developed an adjuvant which will materially lessen the acuteness of this disease, lessen its duration, and possibly help prevent metastasis and recurrence. It will take longer to decide whether the type of healing is to be altered or not, and it will be necessary to reserve for a future paper the explanation of the improvement. The work was undertaken on the basis of treatment of bone and joint tuberculosis. Such satisfactory deposition of calcium was found, that a supplementary series of cases has been started in osteomyelitis and ununited fractures. There is tangible evidence that the splenic extract treatment (s.e.t.) assists the healing of acute osteomyelitis (pyogenic) and is a valuable assistant in the treatment of chronic osteomyelitis (after sequestra, if present, have been removed). There is definite evidence that fractures which have shown very little or no callus formation in periods up to one year have become solid in six to eight weeks.

The secondary anaemias seem to improve.

And still the writer is, as a result of this mass of information, bewildered, for he does not feel that he can state at present whether the improvement comes from control of Koch's bacillus, whether it comes from the stimulation of the reparative processes of the bone itself (possibly through the synovial membrane, or the marrow, or both), whether it comes from the improvement in the blood composition, or whether it comes from the effect on other organs or tissues as a biochemical stimulant or hormone. The literature has been reviewed, and in so far as no article available has given a specific explanation for the improvement of bone or

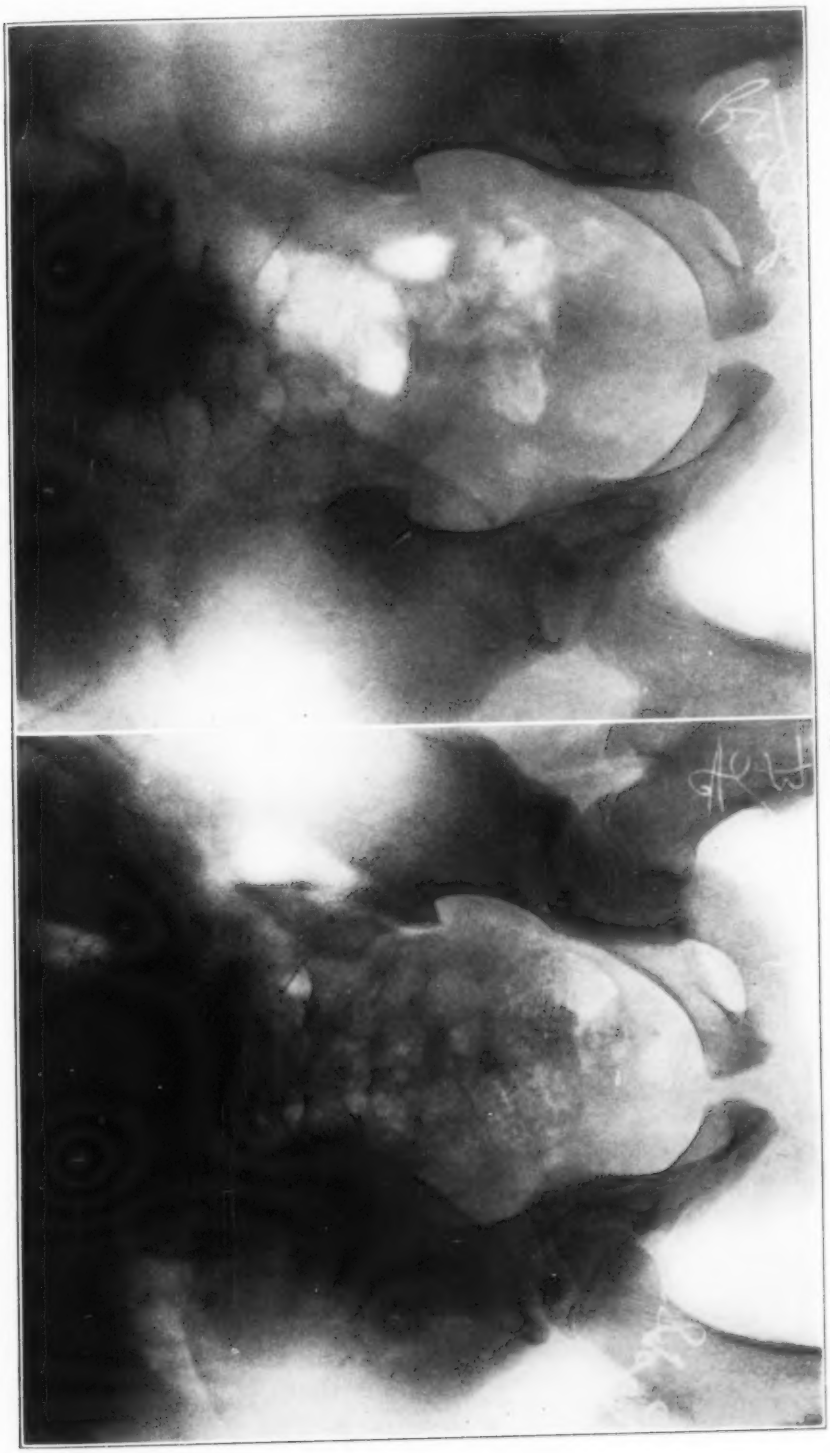

FIG. 19

Case 14 (A. R. 15208)

Left, before treatment. Right, after treatment.

FIG. 20

Case 15 (C. W. 14841)
Left, before treatment. Center, during treatment. Right, after treatment.

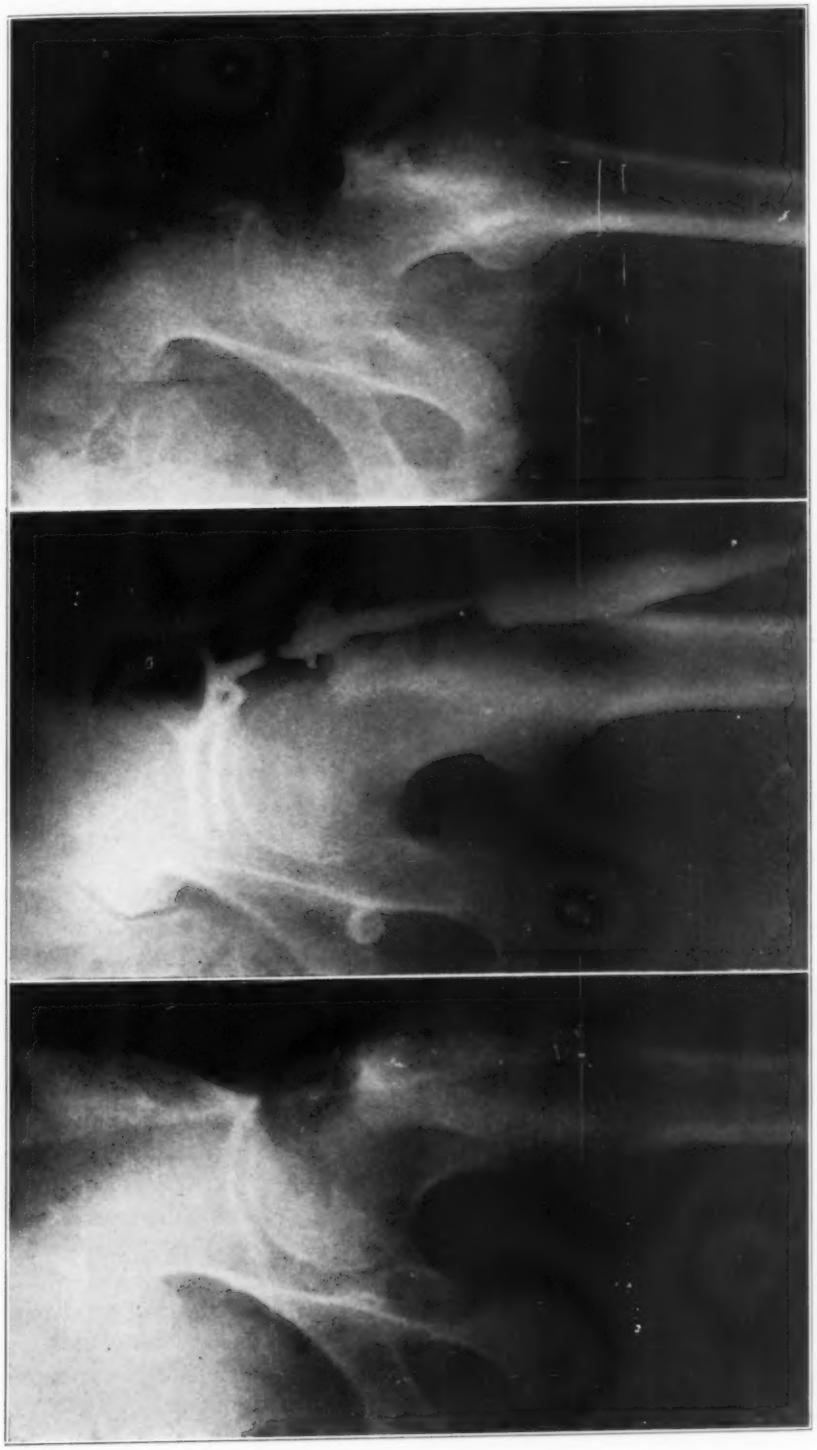

FIG. 21

Case 16 (C. W. 1523)

Left, before treatment. Center, during treatment. Right, after treatment.

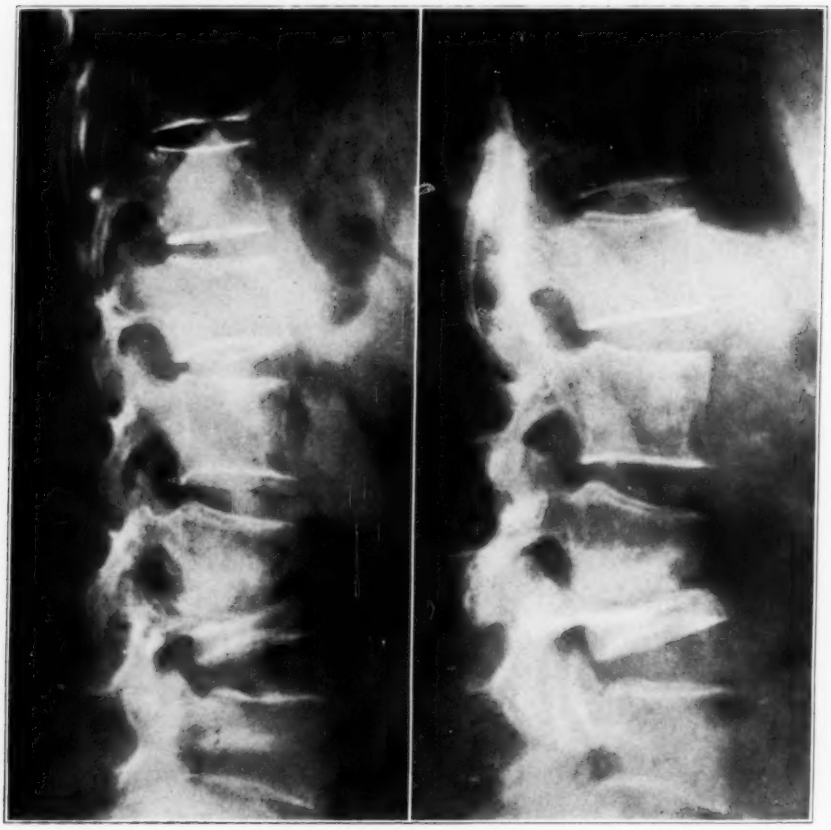

FIG. 22

Case 17 (C. W. 12489)
Left, before treatment. Right, after treatment.

joint conditions under the administration of spleen, these cases are presented without reference to these articles. (Those interested can easily find most of the information on the subject available at present in the work of Dr. Bayle who, in his article of 1931 and in a personal communication, shows that he is still actively working on the subject.)

OBSERVATIONS

As the cases are widely distributed in rural sections of the state, a complete accumulation of data at the beginning of the splenic extract treatment (s.e.t.) was not possible. It seemed best to go right ahead and start treatment and catch up the data later. Whether progress has been made to the satisfaction of everyone will have to be determined by each orthopaedic surgeon as to his own experience in a similar group of cases, under circumstances similar to those described previously in this paper. The observations here presented are being checked by others.

The writer has felt that the x-ray diagnosis was satisfactory in all of

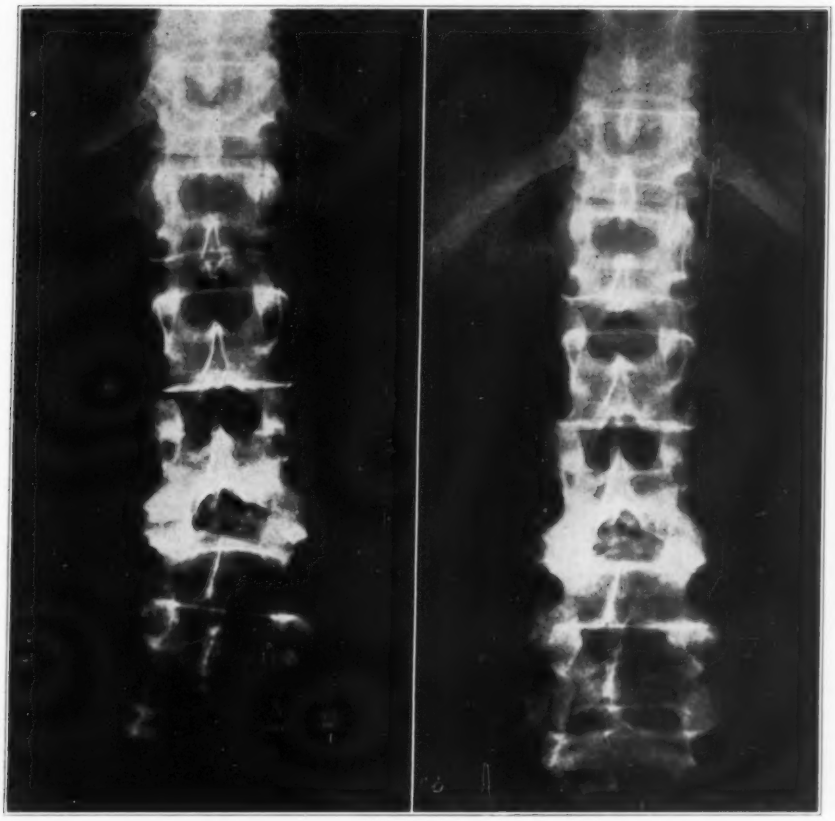

FIG. 23

Case 17 (C. W. 12489)
Left, before treatment. Right, after treatment.

the cases except those of C.P. 15330 and C.W. 16239. In the case of C.P. 15330 the diagnosis was confirmed by pathological examination of the biopsy material. In the case of C.W. 15239 there was a pure culture of bacillus tuberculosis on potato. This was obtained from material from the patient's sinus. (Photographs of both of these patients are available.)

All these facts are brought out in Tables II, III, IV, and V.

SUMMARY

From the foregoing the writer draws the following conclusions:

1. The use of splenic extract in the diet of patients suffering with bone and joint tuberculosis has been found very beneficial, as improvement is noted in the febrile condition, the local reactions, the growth, the weight, the color, the appetite, the blood composition, the deformity, the complications, the roentgen picture, the activity permissible to the patients, and the dispensing with support.

TABLE II

Summary of Cases

Case	No.	Age	Duration of Disease when S.E.T. Began	Complications	Location	Duration of S.E.T.	Duration of Treatment Before Starting S.E.T.
1. F. B.	13092	8 years	2 years	Paralysis of both lower extremities	Spine	1 year, 2 mos.	1 year
2. P. B.	15434	24 years	3 years, 6 mos.	Draining sinus	Sacro-iliac joint	1 year, 2 mos.	1 year
3. L. C.	14078	15 years	Unknown		Hip	1 year, 2 mos.	8 months
4. M. F.	14778	50 years	2 years		Spine	1 year, 2 mos.	4 months
5. P. F.	13386	40 years	10 years		Spine	1 year, 2 mos.	1 year
6. V. F.	16248	10 years	4 months		Hip	1 year, 2 mos.	None
7. R. H.	12244	63 years	Unknown	Paralysis of both lower extremities	Spine	1 year, 2 mos.	1 year, 1 mo.
8. R. H.	7468	10 years	5 years		Spine	1 year, 2 mos.	4 years
9. T. K.	14590	15 years	8 years		Spine	1 year, 2 mos.	6 months
10. R. M.	17241	7 years	3 months		Hip	1 year, 2 mos.	None
11. C. P.	15300	7 years	1 year		Ilium	1 year, 2 mos.	6 months
12. D. P.	15755	5 years	2 months	Paralysis of both lower extremities	Spine	1 year, 2 mos.	None
13. H. R.	9682	10 years	1 month		Spine	1 year, 2 mos.	3 years
14. A. R.	15208	17 years	Unknown	Paralysis of both lower extremities	Spine	1 year, 2 mos.	None
15. C. W.	14841	12 years	6 months		Hip	1 year, 2 mos.	3 months
16. C. W.	15239	41 years	3 years	Draining sinus	Femur	1 year, 2 mos.	None
17. C. W.	12489	39 years	2 years	Paralysis of both lower extremities	Spine	1 year, 2 mos.	1 year, 6 mos.

	Case	No.	Treatment Previous to S.E.T.	Prognosis when S.E.T. Started	Treatment Supplementing S.E.T.
1.	F. B.	13092	Support and recumbency	Paralysis slow in clearing up	Support and recumbency. Recumbency has been unnecessary for several months now.
2.	P. B.	15434	Incision of abscess	No change in sinus	None.
3.	L. C.	14078	Support and recumbency	Unimproved	Support. This has been unnecessary for several months.
4.	M. F.	14778	Support	Unimproved	Support.
5.	P. F.	13386	Support	Improving	Support.
6.	V. F.	16248			Support and recumbency. Recumbency has been unnecessary for some time.
7.	R. H.	12244	Support and recumbency	Still paralyzed	Support and recumbency. Recumbency has been unnecessary for six months.
8.	R. H.	7468	Support and recumbency	Improvement very slow	Support and recumbency. Recumbency has been unnecessary for several months.
9.	T. K.	14590	Support	No improvement	Support.
10.	R. M.	17241			Support and recumbency.
11.	C. P.	15300	Support and recumbency	No improvement	Support and recumbency. Recumbency has been unnecessary for some time.
12.	D. P.	15755			Support and recumbency.
13.	H. R.	9682	Support and recumbency	Improvement slow	Support and recumbency. Recumbency has been unnecessary for some time.
14.	A. R.	15208			Support and recumbency. Recumbency has been unnecessary for four months.
15.	C. W.	14841	Support and recumbency	No improvement	Support and recumbency. Recumbency has been unnecessary for several months.
16.	C. W.	15239			None.
17.	C. W.	12489	Support and recumbency	Improvement slow	Support and recumbency. Recumbency has been unnecessary for several months.

TABLE III

Results of Treatment

	Case	No.	Temperature (Degrees)	Height (Inches)	Weight	Weight Variation Since S.E.T. Started	Ideal Weight	Color	Appetite	Blood * Composition	Pain
1.	F. B.	13092	98.6	42	45	Gain	39	Improved	Improved	Improved	Less
2.	P. B.	15434	98.6	68	160	Gain	154	Improved	Improved	Improved	Less
3.	L. C.	14078	98.6	59	88	Gain	90	Improved	Improved	Improved	Less
4.	M. F.	14778	98.6	60	125	Gain	116	Improved	Improved	Improved	Less
5.	P. F.	13386	98.6	60	140	Gain	118	Improved	Improved	Improved	Less
6.	V. F.	16248	98.6	60	95	Gain	91	Improved	Improved	Improved	Less
7.	R. H.	12244	98.6	60	120	Gain	116	Improved	Improved	Improved	Less
8.	R. H.	7468	98.6	47	56	Gain	50	Improved	Improved	Improved	Less
9.	T. K.	14590	98.6	56	82	Gain	80	Improved	Improved	Improved	Less
10.	R. M.	17241	98.6	41	33	Gain	38	Worse	Improved	Improved	Less
11.	C. P.	15300	98.6	40	35	Gain	36	Improved	Improved	Improved	Less
12.	D. P.	15755	98.6	38	20	Gain	33	Improved	Poor	Improved	Less
13.	H. R.	9682	98.6	45	52	Gain	46	Improved	Improved	Improved	Less
14.	A. R.	15208	98.6	61	100	Gain	106	Improved	Improved	Improved	Less
15.	C. W.	14841	98.6	50	65	Gain	58	Improved	Improved	Improved	Less
16.	C. W.	15239	98.6	70	150	Gain	162	Same	Improved	Improved	Less
17.	C. W.	12489	98.6	60	95	Gain	119	Improved	Improved	Improved	Less

* See Tables IV and V.

Case	No.	Progress of Complications Other than Abscess	Clinical Progress of Abscess † if Present When S.E.T. Started	Progress of Gross Deformity	Changes in Tuberculous Abscess (Roentgenographic)
1. F. B.	13092	Paralysis disappeared		Lateral angulation less	No abscess
2. P. B.	15434	Sinus closed	Abscess disappeared	No deformity	No abscess
3. L. C.	14078			Slight increase	No abscess
4. M. F.	14778			Very slight deformity	No abscess
5. P. F.	13386			Kyphosis slightly increased	No abscess
6. V. F.	16248			No deformity	No abscess
7. R. H.	12244	Paralysis disappeared		No increase	No abscess
8. R. H.	7468		Abscess not clinically demonstrable	Lateral deformity less	Abscess about the same
9. T. K.	14590			Deformity same	No abscess
10. R. M.	17241		Abscess improved	Deformity has increased	No abscess
11. C. P.	15300		Abscess disappeared	Deformity less	No abscess
12. D. P.	15755	Paralysis disappeared	Abscess has not improved	Deformity same	No abscess
13. H. R.	9682			Deformity less	No abscess
14. A. R.	15208	Paralysis disappeared	Abscess not clinically demonstrable	Deformity less	Abscess same
15. C. W.	14841			No increase	No abscess
16. C. W.	15239	Sinus closed	Abscess disappeared		No abscess
17. C. W.	12489	Paralysis disappeared		Deformity less	No abscess

† No case, in which s.e.t. has been started at beginning of disease or in which no abscess was present when s.e.t. was started, has so far developed an abscess.

TABLE III (*continued*)

RESULTS OF TREATMENT (*continued*)

	Case	*No.*	*Calcification of Lesion (Roentgenographic)*	*Detail of Lesion (Roentgenographic)*	*Progress of Destruction (Roentgenographic)*	*Evidences of Fusion (Roentgenographic)*	*Activity of Patient at This Time*
1.	F. B.	13092	Increased	Improved	Less	Actual fusion seen	Goes to school.
2.	P. B.	15434	Increased	Improved	Less	Actual fusion	Works as waiter.
3.	L. C.	14078	Increased	Improved	Less	Actual fusion	Helps on farm.
4.	M. F.	14778	Very little increase	Improved	Considerable absorption between twelfth dorsal and first lumbar	Actual fusion between first and second lumbar	Ambulatory. No work.
5.	P. F.	13386	Marked increase	Improved		Actual fusion	Ambulatory. No work.
6.	V. F.	16248	Increased	Improved	Joint space narrower	A little bony fusion	Goes to school.
7.	R. H.	12244	Considerable increase	Improved	No more destruction	Actual fusion	Ambulatory. No work
8.	R. H.	7468	Increased	Improved	No increase	Not visible	Goes to school.
9.	T. K.	14590	Marked increase	Improved	No more destruction	Actual fusion	Goes to school.
10.	R. M.	17241	Less	Unimproved	Joint space obliterated	Actual fusion	Recumbent.
11.	C. P.	15300	Increased	Improved	Less	No fusion	Ambulatory. Guarded activity.
12.	D. P.	15755	Increased	Same	Increased	Fusion	Recumbent.
13.	H. R.	9682	Increased	Improved	No further destruction	Fusion	Goes to school. Leads normal life.
14.	A. R.	15208	Increased	Improved	No more destruction	Actual fusion	Goes to school.
15.	C. W.	14841	Increased	Improved	No more destruction	Actual fusion	Ambulatory. Guarded activity.
16.	C. W.	15239	Increased	Improved	Small sequestrum present		Ambulatory. Not allowed to work.
17.	C. W.	12489	Increased	Improved	No more destruction	Actual fusion	Ambulatory. Does some of housework.

TABLE IV

Analysis of Schilling Differential Blood Count

	Case	No.	Basophils	Eosinophils	Myelocytes	Juvenile	Stab	Segmented	Lymphocytes	Monocytes	Shift to Left	Stage of Infection	Severity of Infection	Resistance	Progress	Lymphocyte-Monocyte Ratio
1.	F. B.	13092	0	6	0	2	8	55	25	4	15	Chronic	Slight	Good	Healing	25:4
2.	P. B.	15434	0	2	0	0	24	37	35	2	39.9	Chronic	Moderate	Low	Healing	35:2
3.	L. C.	14078	0	5	0	2	9	53	27	4	17.2	Chronic	Slight	Good	Healing	27:4
4.	M. F.	14778	0	0	0	4	26	32	30	8	65.9	Acute	Severe	Good	Satisfactory	30:8
5.	P. F.	13386	0	0	0	2	25	27	29	17	50	Acute	Severe	Good	Not sufficient healing	29:17
6.	V. F.	16248	0	0	3	1	25	53	12	6	35.4	Chronic	Moderate	Good	Healing not satisfactory	12:6
7.	R. H.	12244	0	0	0	1	18	37	37	7	33.9	Acute	Moderate	Good	Healing	37:7
8.	R. H.	7468	1	1	0	0	7	33	57	1	17.5	Chronic	Slight	Poor	Healing	57:1
9.	T. K.	14590	0	2	0	0	11	32	43	12	25.5	Chronic	Moderate	Good	Healing	43:12
10.	R. M.	17241	1	2	0	6	14	33	29	15	64.6	Acute	Moderate	Good	Unsatisfactory	29:15
11.	C. P.	15300	0	0	3	1	28	50	13	5	37.9	Chronic	Moderate	Good	Healing not satisfactory	13:5
12.	D. P.	15755	0	1	0	1	6	70	18	4	9.0	Chronic	Slight	Good	Healing	18:4
13.	H. R.	9682	0	8	0	1	3	17	69	3	19.0	Chronic	Slight	Normal	Healed	69:3
14.	A. R.	15208	0	1	1	2	12	52	28	4	22.0	Chronic	Moderate	Good	Healing	28:4
15.	C. W.	14841	3	5	2	4	3	63	16	4	12.5	Chronic	Slight	Good	Healing	16:4
16.	C. W.	15239	0	1	0	0	13	65	18	3	16.7	Chronic	Slight	Good	Healing	18:3
17.	C. W.	12489	0	0	0	4	30	42	15	9	44.7	Chronic	Severe	Good	Healing unsatisfactory	15:9

TABLE V

ANALYSIS OF BLOOD COMPOSITION

Case	No.	Red Blood Cells (per cubic millimeter)	Hemoglobin (per cent.)	White Blood Cells (per cubic millimeter)
1. F. B.	13092	4,360,000	88	9,000
2. P. B.	15434	4,024,000	80	6,400
3. L. C.	14078	4,700,000	90	6,500
4. M. F.	14778	3,184,000	62	5,000
5. P. F.	13386	4,616,000	80	5,000
6. V. F.	16248	4,700,000	88	6,800
7. R. H.	12244	3,072,000	66	7,400
8. R. H.	7468	4,190,000	86	7,200
9. T. K.	14590	4,184,000	62	8,200
10. R. M.	17241	4,400,000	80	6,500
11. C. P.	15300	4,500,000	70	7,600
12. D. P.	15755	5,000,000	90	10,500
13. H. R.	9682	4,330,000	87	8,760
14. A. R.	15208	4,790,000	96	7,920
15. C. W.	14841	4,800,000	90	6,200
16. C. W.	15239	4,640,000	90	17,250
17. C. W.	12489	4,470,000	83	14,200

2. Improvement from splenic extract treatment probably will be more apparent to those who are unable to enforce a strict compliance with the accepted ideal treatment,—*i.e.*, support, recumbency, heliotherapy, proper feeding, and proper aeration.

3. The production of splenic extract is possible and the distribution is practicable.

4. It is possible to obtain the cooperation of patients in adopting the splenic extract diet, even of those in remote sections.

5. Splenic extract treatment has also produced improvement in osteomyelitis (acute and chronic) and in ununited fractures. This investigation is well under way.

6. Enough improvement has been shown in the blood composition to stimulate further study of this phase.

7. The writer cannot explain the improvement gained by the administration of splenic extract. Various explanations given so far may all be true, but these investigations lead to the belief that as yet there is no certainty as to which is the most important factor.

The author wishes to acknowledge the scientific assistance in this investigation given by Mr. C. Braxton Valentine, Chemical Director of the Valentine's Meat-Juice Company, and the extract of spleen used in these experiments which was supplied by this Company.

REFERENCES

BAYLE, J. C.: L'Opothérapie Splénique. Traitement de Choix de la Tuberculose. Presse Méd., XXXIII, 1266, 1925.

BAYLE, J. C.: L'Opothérapie Splénique. Traitement Général de la Tuberculose. Rev. Gén. de Clin. et de Thérap. (J. Practiciens), XLV, 101, 1931.

FLIEGEL, OTTO: Calf-Milt Diet in the Treatment of Suppurative Tuberculosis of Joints. J. Bone and Joint Surg. XII, 788, Oct. 1930.

METHODS OF MEASURING THE PRESSURE OF THE INTERVERTEBRAL DISC*

BY CHARLES K. PETTER, M.D., OAK TERRACE, MINNESOTA

Senior Resident Physician, Glen Lake Sanatorium

In 1904 and 1911 Fick described the anatomy of the intervertebral disc; and prior to 1926 many reports are to be found of abnormalities, injuries, and other pathology. The extensive work of Schmorl regarding the anatomy, physiology and pathology of the disc has recently been published. Dr. Geist suggested the present study.

It is commonly known that on cross section of an intervertebral disc the cut surface bulges. The observations of others have led to the statement that, in addition to the superincumbent weight and ligamentous pull which act as an external force on each disc, there also exists an internal or expansive force. We have endeavored to measure if possible the magnitude of this internal force.

All observations have been made on spines of individuals dying of tuberculosis, at Glen Lake Sanatorium, and the autopsies were performed as soon after death as possible (average time, four hours after death).

Our first observation was that a "block" made up of two or more vertebral bodies and their intervening discs became appreciably longer when removed from the body (Fig. 1). This was determined by affixing

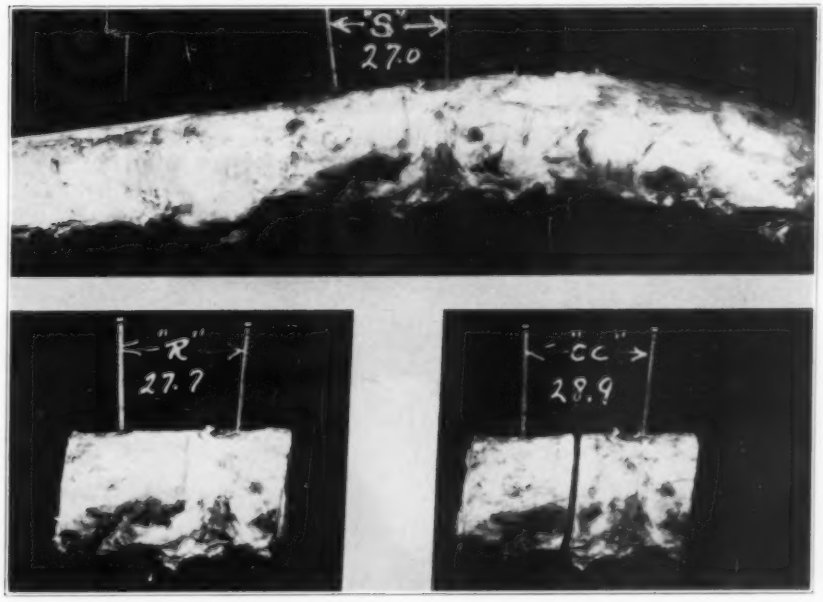

FIG. 1

Segment of spine showing values for *S*, *R*, and *CC*.

*Read by invitation at the Annual Meeting of the American Orthopaedic Association, Toronto, Canada, June 18, 1932.

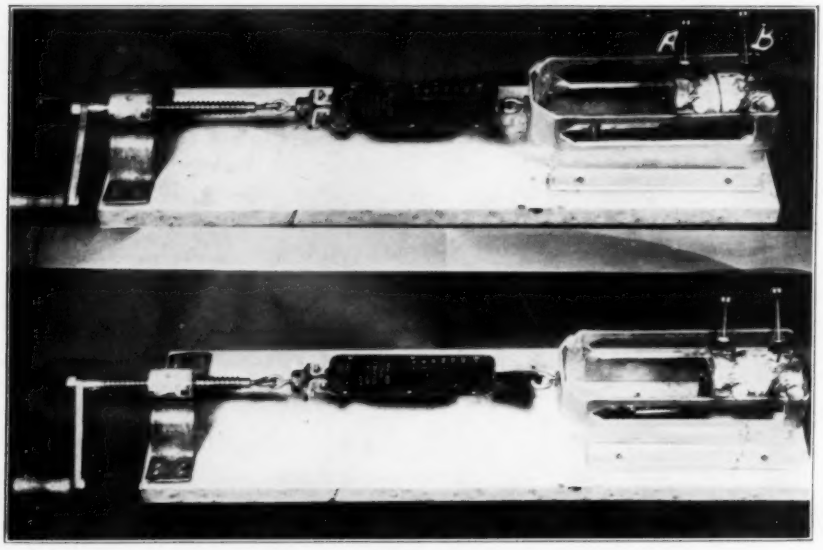

FIG. 2

"Compressor" with block in position, scale at zero, showing space between bodies which is overcome, in lower picture, by applying pressure of twenty-five pounds.

markers to each body and recording the distance S between them while *in situ*, and the distance R when removed. Further release of the restraining forces was accomplished by sectioning the annulus fibrosis of each disc throughout its circumference, and it was then found that the distance between markers CC had further increased *in most cases*.

Our first group of cases showed an average increase of seven-tenths of one millimeter in distance between markers upon removal of the block, and a further increase of one and two-tenths millimeters when the annulus fibrosis was cut.

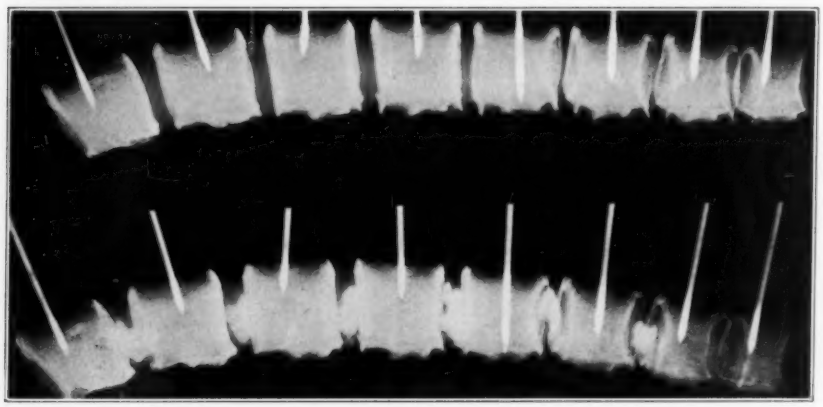

FIG. 3

Roentgenogram of spine segment before and after injection of each disc showing increased curve produced by injection.

TABLE I

EXPANSION AND COMPRESSION DATA ON SERIES OF DISCS STUDIED

Disc	*Case*	*Sex*	*Age*	*B.L.*	*HR. PM.*	*S*	*R*	*CC*	*Pressure*
4 L	3715	F	21	163	8	32.0 mm.	32.75 mm.	33.75 mm.	32 pounds
	3337	M	46	166	8	39.5 mm.	40.0 mm.	41.0 mm.	32 pounds
	1630	M	51	181	12	36.0 mm.	36.0 mm.	36.5 mm.	32 pounds
	3605	F	44	161	2	33.0 mm.	34.0 mm.	35.0 mm.	32 pounds
2 L	3715					30.0 mm.	31.0 mm.	32.0 mm.	32 pounds
	3337					34.0 mm.	35.0 mm.	36.0 mm.	28 pounds
	1630					30.0 mm.	30.0 mm.	30.75 mm.	30 pounds
	3605					30.5 mm.	31.5 mm.	32.5 mm.	30 pounds
	2854	F	23	161	15	28.5 mm.	29.0 mm.	29.5 mm.	30 pounds
	4596	F	24	162	1.5	37.5 mm.	38.0 mm.	38.5 mm.	35 pounds
	4709	F	50	156	4	38.0 mm.	39.0 mm.	40.0 mm.	30 pounds
	4717	F	31	164	9.5	40.0 mm.	40.5 mm.	42.0 mm.	30 pounds
	4712	M	22	173	5	40.0 mm.	40.5 mm.	42.0 mm.	32 pounds
1 L	2905	F	29	163	9	35.5 mm.	35.5 mm.	37.0 mm.	24 pounds
	4257	M	43	174	8	37.0 mm.	37.0 mm.	38.5 mm.	32 pounds
	4785	F	21	162	5	35.5 mm.	35.5 mm.	37.5 mm.	32 pounds
	3732	M	27	179	8	37.5 mm.	38.0 mm.	38.6 mm.	25 pounds
12 D	3715					25.0 mm.	26.0 mm.	26.75 mm.	30 pounds
	4357	F	21	133	1.5		26.5 mm.	28.0 mm.	30 pounds
11 D	2905					26.0 mm.	26.0 mm.	28.0 mm.	30 pounds
	4257					29.5 mm.	29.5 mm.	30.5 mm.	28 pounds
	4785					30.5 mm.	31.0 mm.	32.5 mm.	32 pounds
10 D	3715					23.0 mm.	23.5 mm.	24.0 mm.	30 pounds
	3605					22.5 mm.	23.5 mm.	24.0 mm.	30 pounds
	2854					25.0 mm.	25.0 mm.	26.0 mm.	30 pounds

The question then arose as to how this expansile force could be measured. Therefore, a device was constructed by which a known force could be applied to the sectioned disc in an attempt to reduce the measurement *CC* to *R*. This "compressor" consists of a fixed cup, *A*, into which one vertebral body is fastened, and a second cup, *B*, to receive the other body. This second cup is pulled against the first by a screw which has a spring scale attached.

Markers are driven into the vertebrae adjacent to the disc to be studied and *S* recorded. The "block" is removed from the body by sectioning the discs above and below the one in question and by cutting the pedicles of the adjacent vertebrae. *R* is then recorded. After the an-

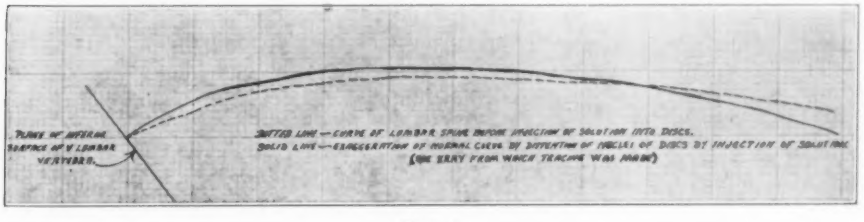
DOTTED LINE—CURVE OF LUMBAR SPINE BEFORE INJECTION OF SOLUTION INTO DISCS.
SOLID LINE—EXAGGERATION OF NORMAL CURVE BY DISTENTION OF FACIAL OF DISCS BY INJECTION OF SOLUTION
(THE X-RAY FROM WHICH TRACING WAS MADE)

FIG. 4

Graphic representation of curves shown in Fig. 3.

TABLE II

AVERAGE EXPANSION AND AVERAGE PRESSURE REQUIRED FOR REDUCTION

4th Lumbar	0.9 mm. expansion	Reduced by 32 pounds' pressure
2nd Lumbar	0.97 mm. expansion	Reduced by 30.6 pounds' pressure
1st Lumbar	1.4 mm. expansion	Reduced by 28.2 pounds' pressure
12th Dorsal	1.1 mm. expansion	Reduced by 30.0 pounds' pressure
11th Dorsal	1.5 mm. expansion	Reduced by 30.6 pounds' pressure
10th Dorsal	0.66 mm. expansion	Reduced by 30.0 pounds' pressure
Average	1.08 mm. expansion	Reduced by 30.2 pounds' pressure

nulus fibrosis is sectioned and *CC* observed, the "block" is fastened into the compressor and pressure applied to reduce *CC* to *R* (Fig. 2).

As a definite example of what actually takes place, we see from Table I that in Case 3715, observing the fourth lumbar disc:

S was found to be 32 millimeters; *R*, 32.75 millimeters; and *CC*, 33.75 millimeters.

A force of thirty-two pounds was required to reduce *CC* to *R*.

It is to be noted that the figures for expansion and compression show a variation, but the average for the group is found to be:

An expansion of 1.08 millimeters is reduced to normal by a pressure of thirty and two-tenths pounds.

The x-ray shadow of an opaque solution (sodium iodid, ten per cent.), injected into the center of the disc, shows that it is definitely limited, apparently by the annulus fibrosis. It was found that from eight-tenths to one and five-tenths cubic centimeters of solution was all that could be forced into these discs and, when this point was reached, the disc was slightly bulging.

In a large block, as the one shown, the injections produced an exaggeration of the normal curves of the segment of spine studied (Figs. 3 and 4).

CONCLUSION

1. A very definite expansion of the intervertebral disc occurs upon its removal from the body, with further expansion when the annulus fibrosis is sectioned, the average being one and eight-hundredths millimeters.

2. An appreciable amount of pressure is required to reduce this expansion, the average being thirty and two-tenths pounds.

EROSIONS OF THE ARTICULAR SURFACES OF THE KNEE JOINT

BY E. LAWRENCE KEYES, M.D., ST. LOUIS, MISSOURI

From the Department of Anatomy, Washington University, School of Medicine *

Certain lesions of articular surfaces were recently observed in many knee joints of a series of human cadavera. Some of these lesions do not appear to have been described previously, and others only briefly. Their causes and consequences are equally obscure. This paper aims simply to point out the gross features of the lesions, together with their frequency of occurrence and situation, based on a study of seventy-four successive unselected dissecting-room cadavera.†

Definition. The lesions under consideration have been termed "erosions", a name suggested by their appearance and location, and convenient for the description that follows.

Description of the Erosions. All erosions were found to be confined to the articular surfaces of the bones of the knee joint. The form varied; some were nearly circular in outline, others oval, and others of irregular form. The oval form was most common. In sizes they varied from two millimeters to four centimeters in diameter. Some appeared as a mere local roughening of the superficial layers of cartilage; others were punched-out lesions partly perforating the articular cartilage, and a few completely perforated the cartilage and exposed underlying bone. Synovial surfaces were ordinarily smooth and glistening. Multiple lesions within a single knee joint were the rule. Opposing bony surfaces were usually involved. Thus, it was rare to find an erosion of the patella without a corresponding erosion of the patellar surface of the femur.

Incidence. Erosions were found in the knee joints of forty-seven of the seventy-four cadavera examined, an incidence of sixty-three and five-tenths per cent. Among fifty-seven male cadavera, the incidence was sixty-four and nine-tenths per cent.; among seventeen female cadavera, it was sixty per cent. The incidence among thirty-two white cadavera was sixty-eight and seven-tenths per cent., compared to an incidence of sixty per cent. among forty-two negro cadavera.

Side Involved. Both knee joints of forty cadavera presented erosions; one knee joint only in seven cadavera. Of the seven latter, five were right knees and two were left.

Location of the Erosions. The knee bones of the forty-seven affected cadavera were involved in the following order of frequency: patellae, forty-two right and thirty-eight left; femora, thirty-five right and thirty-five left; and tibiae, fifteen right and ten left.

* This investigation was aided by a grant from the Science Research Fund of the Rockefeller Foundation.

† The author wishes to express to Mr. Richard A. Sutter and to Mr. William S. Wallace his appreciation of their assistance in the collection of the material for the present study.

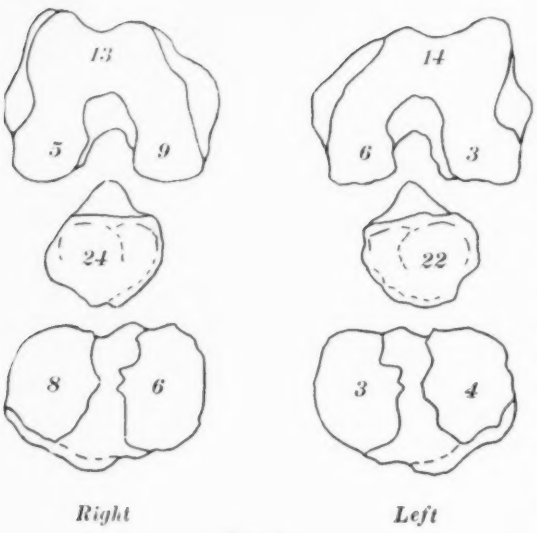

FIG. 1

Location and frequency of the erosions in the twenty-five abnormal cadavera.

The patellar erosions were all single, the erosions elsewhere were often multiple. There was usually one erosion to each articular subdivision. Of the twenty-five cadavera with erosions, forty-six patellae, representing twenty-four right knees and twenty-two left, were eroded; as were twenty-seven patellar surfaces of femora, eight lateral condyles of femora, fifteen medial condyles of femora, twelve lateral condyles of tibiae and eight medial condyles of tibiae (Fig. 1). The average number of erosions per affected cadaver was five; the average number per eroded knee joint was two and a half.

Relation to Age. The average age of all cadavera of the series was fifty-four and four-tenths years. The average age of cadavera with eroded knee joints was fifty-nine and nine-tenths years. Only twelve cadavera out of the thirty-two below the age of fifty had erosions, compared to thirty-five out of the forty-two over the age of fifty. The youngest abnormal cadaver was twenty-six; the youngest normal cadaver was sixteen. Past the sixtieth year there were thirty-one cadavera of which only four were free from knee-joint erosions.

There were also more erosions per knee joint among older cadavera. Six cadavera, averaging seventy-one and eight-tenths years, exhibited erosions on all six bones of the two knee joints; nine cadavera, averaging sixty-three and three-tenths years, had erosions on five of the bones; thirteen cadavera, averaging sixty-four and six-tenths years, presented four of the bones eroded; five cadavera, averaging fifty-one years, showed three of the bones involved; ten cadavera, averaging fifty-six and one-tenth years, revealed but two affected bones; and three cadavera, averaging forty-six and seven-tenths years, suffered a single eroded bone.

In addition to being more numerous in the knee joints of older cadavera, the erosions were generally more extensive. Thus the three cadavera, possessing erosions extensively exposing bone, averaged seventy-three and seven-tenths years of age, well above the average of affected cadavera,—namely fifty-nine and nine-tenths years.

Relation to Disease and Trauma. The cause of death in all the cadavera of this series was known. Examination of the case histories afforded

no aid in associating the lesions with symptoms or with trauma.

Erosions Elsewhere. Erosions, similar to those described in the knee, were observed in the shoulder and radiocarpal joints of some cadavera. No attempt was made to include these lesions in the study, however.

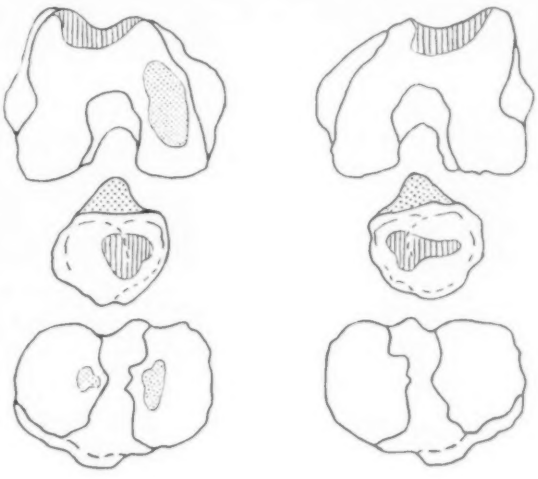

FIG. 2

Erosions in the knee joints of a negro male cadaver, aged sixty-five years. The striated areas represent striated bone exposed. The stippled areas represent simple erosions.

COMMENT

Erosions of the articular surfaces of the knee, shoulder, radiocarpal, and temporomandibular joints have been described by Meyer.[1] His descriptions of the knee-joint lesions are confined to those occurring on the patella. The erosions of the condyles of the femur and of the tibia noted in this study do not appear to have been recorded previously, although they are included in a study at present in progress [2]. Lesions similar to those here described have been observed in the carpometacarpal joints of apparently normal slaughter-house animals by Bennett and Bauer [3].

That the lesions in man have their origin during life is conclusively proved by their demonstration at necropsy. Myers [2] very kindly showed the author some knee joints opened at necropsy in which the erosions were readily seen.

The cause of the lesions is obscure. This study throws some light on certain etiological factors. The erosions occur in the majority of cadavera over fifty, and are more numerous and more extensive in older cadavera. They affect males more often than females. They are usually bilateral. The pattern of the erosions is likely to be similar in the two knees. Opposing joint surfaces are apt to be involved, particularly the patella and the patellar surface of the femur. Only the articular cartilage of the joint structures appears to be affected. The lesions sometimes lead to exposure of large bony surfaces within the joint. These observations point to age and trauma as important causative factors. The lesions would seem to be degenerative changes.

REFERENCES

1. MEYER, A. W.: Further Observations upon Use-Destruction in Joints. J. Bone and Joint Surg., IV, 491, July, 1922.
2. KEEFER, C., and MYERS, W. K.: Personal communication by the latter.
3. BENNETT, G. A., and BAUER, W.: A Systematic Study of the Degeneration of Articular Cartilage in Bovine Joints. Am. J. Path., VII, 399, 1931.

MARCH FOOT

BY J. S. SPEED, M.D., AND T. H. BLAKE, M.D., MEMPHIS, TENNESSEE

Due to lack of understanding of the etiology of the condition, march foot is the name given to a definite clinical entity, consisting of a painful swelling of the forefoot often associated with an insidious spontaneous fracture of one of the metatarsal bones. The condition has been well recognized for many years, especially by the German and French Military Surgeons who frequently encountered it among their troops after strenuous duties or long marches,—hence the name of "march foot".

The first description found in the literature was by Breithaupt [4] in 1855, who clearly distinguished it from the usual anterior metatarsal strains or from Morton's toe, a malady from which he himself suffered.

Very little has been added to his original clinical description, although he did not observe or recognize the associated spontaneous fractures of the metatarsal bones which we now know are present in the majority of the well developed cases. Since that time numerous articles have appeared in the German and French literature under the titles of "Foot Tumor", "Foot Oedema", "Syndesmitis Metatarsae" and "Pied Forcé".

The usual history and clinical appearance is typical. A soldier after a long march, or a civilian who has been subjected to excessive foot strain, begins to complain of an indefinite pain in the forefoot, and some tenderness over the anterior portion of the second or third metatarsal. This is not sufficient to disable the patient and he continues with his duties only to have the disability increase, and after a few days a definite swelling is noticed involving the dorsal surface of the forefoot. The condition improves with rest, but resumption of use of the foot aggravates the condition and it is usually only after several such attacks that the patient first consults a physician.

Very few patients give a history of any direct trauma, either severe or trivial, that could account for the symptoms.

Examination reveals an oedematous forefoot, most marked over the metatarsal region. The skin appears shiny and tense, there is some localized heat and redness. The swelling is usually limited entirely to the dorsum of the foot, most marked in the region of the second and third metatarsals, the plantar surface of the foot only being involved in the more extreme cases. The swelling pits on pressure with the sensation that most of the oedema and tenderness lies deep beneath the fascia.

In the later stages, after two or three weeks, the swelling has become more localized over the shaft of one of the metatarsals and a firm tumor-like mass can be definitely distinguished, attached to the bone. Bony crepitus has never been felt, although manipulation of the affected metatarsal produces localized pain at the point of fracture or beginning fracture. Motion in the ankle joint and uninvolved parts of the foot is free and painless.

There is usually a definite limp, and, if a fracture is present, the patient cannot stand with the weight on the ball of the affected foot.

Clinically the cases may be divided into two groups. The first group has the usual onset and progresses to the stage of swelling over the dorsum of the foot, and localized tenderness over the affected metatarsal. With rest and treatment, and frequently without treatment, the process apparently becomes arrested and after a week or ten days the swelling and pain subside and the foot returns to normal, without formation of a localized tumor or the occurrence of a spontaneous fracture. Roentgenograms taken during the course of the active symptoms or at intervals afterwards fail to show any bony changes.

The second group, in which the onset is identical with the first, progresses through the stages of periosteal proliferation, spontaneous fracture, and excessive callus formation. The duration of symptoms in this group is naturally much more prolonged, the average being two to three months. At the end of this time the fracture is united, the callus gradually condenses and eventually disappears, leaving a bone which is perfectly normal clinically and in which the x-ray shows no residual changes or at most only a slight thickening of the cortex at the site of the fracture.

There is considerable disagreement regarding the percentage of cases in which spontaneous fractures occur. This is probably due to the personal equation in selecting the early cases, to the conditions under which they were observed, and to the improvement in x-ray technique which has enabled us to detect the fine fracture lines which would not be visible in a poor roentgenogram. Most of the larger series were reported from the German Army many years ago. These cases were under careful medical supervision, were recognized early, and the patients were kept off their feet until the symptoms disappeared. X-ray studies were not routine and it is probable that many fractures were not detected. Even with the best roentgenograms today, the fracture line is often difficult to make out, due to the fact that there is no displacement of the fragments and the fracture site is obscured by an abundant callus.

Bähr [1], states that in 2146 foot tumors there were fractures in 877 or forty-one per cent. The percentages given by other authors vary from twenty to ninety. It is probable that in civilian life only the more severe cases seek medical attention or are recognized as march feet, consequently the percentage is much higher.

Although many theories have been advanced regarding the etiology of the condition, as yet no explanation has been offered which is entirely satisfactory. The reader is referred to the rather voluminous literature for the details of these theories or to a recent article by Straus [19] in which a summary of the various articles is given.

Unquestionably the incipiency of the disease is associated with an excessive or prolonged foot strain. It is possible that this results in a fatigue of the muscles and stretching of the ligaments supporting the concavity of the metatarsal bones and the anterior metatarsal arch. This

allows the weight to fall heavily on the unsupported heads of the second and third metatarsals and eventually produces a fracture by repeated tension and trauma. This is shown in the present series, by the fact that five of the cases reported were of nurses who were on their feet an unusual amount, walking on tile floors. Two of the other cases were patients who had recently engaged in occupations requiring much walking on the streets. There was one who had recently gained much weight and walked in spike-heeled shoes. Again, all the original cases reported were in soldiers who participated in long or protracted marches. All of the authors' patients gave a history of previous foot ailments, the usual being bunions, calluses under metatarsal heads, and rigidity of the tarsal and tarso-metatarsal joints. This shows that some type of chronic foot strain has been in progress over a more or less long period of time.

Disturbance in function of the anterior metatarsal arch as an etiological agent is strongly supported by a study of the mechanics of weight-bearing in the anterior metatarsal arch. With the foot at rest or with the heel flat on the floor, the majority of the weight falls on the heads of the first and fifth metatarsals, but when the heel is raised in the act of walking the anterior arch flattens and the weight is shifted to the heads of the second, third, and fourth metatarsals. This is evidenced, not only by observation of the normal foot, but by the fact that in conditions where the normal flexibility of the anterior arch is lost, callus formation on the ball of the foot is most frequently found under the heads of these three bones, showing that pressure is greatest at these points.

It is impossible to say whether the spontaneous fracture is directly the result of mechanical stress on the bone or whether it is indirectly caused by a disturbance in the nutrition of the metatarsal from a myositis and fibrosis of the intrinsic muscles attached to these bones, interfering with their blood supply.

Study of the roentgenograms in the authors' group of cases has been most interesting and instructive. They have helped greatly to explain the clinical course of this affection and to explain the pathological changes noted in the bone after the "foot tumor" has become fully developed.

The roentgenograms of a march foot are at times difficult of interpretation if only one set of pictures are made, but if a series of roentgenograms are made, beginning early after the onset of symptoms and repeated every two weeks, it will be seen that the bone changes follow an orderly course, differing very little from the healing of an ordinary fracture. Good roentgenograms with clear detail are essential to bring out the fine fracture line which at first is very difficult to see and later may be obscured by excessive callus formation surrounding it. A magnifying glass will assist in identifying the fracture line.

We have been fortunate in securing a complete series of roentgenograms in several cases, starting before there was any evidence of bone changes and following them through the various stages of early periosteal proliferation, the appearance of the fracture line, the formation of ex-

cessive callus, the healing of the fracture with contraction of the callus, and eventual restoration of the apparently normal bone. The normal sequence of changes shown by the roentgenograms are as follows:

1. If taken very soon after onset of symptoms the bones will be found to be entirely negative and only swelling of soft tissues will be noted.

2. After one to three weeks there will be a little periosteal fuzziness at the site of the beginning fracture; very close observation may show a minute line of fracture. Occasionally the fracture appears before the periosteal reaction is seen.

3. A little later the periosteal shadow will become more distinct and circumscribed and it will be noted that this callus is overabundant for the size of the bone involved and the size of the fracture. At this time the fracture usually can be seen distinctly and will be found to have an irregular outline.

4. The fracture is next showing signs of union and the callus is more dense and well circumscribed into a spindle shape. At this stage and in the preceding one, this condition has been mistaken for sarcoma which it simulates to some extent.

5. Pictures taken six months later will show solid union with absorption of the excess callus. The shaft will appear normal except for a small amount of residual cortical thickening.

Displacement of the fragments in these fractures is very infrequent. This is probably explained by the fact that the fracture is produced gradually, without violence to separate the ends, and that the periosteal thickening and early callus formation are present simultaneously or preceding the actual dissolution of the bone. The protective splinting afforded by the other metatarsals is probably also a factor. Case 2 (Fig. 3) is the only patient in this series which showed an appreciable displacement. There was no history of trauma in this case.

Rarely the fracture line appears before there is any sign of periosteal proliferation. Such a case is illustrated in Case 6 (Fig. 2). Later callus appeared, just as in an ordinary fracture, and healing progressed in the usual manner.

A more frequent finding is for the x-ray to show an actively proliferating mass of callus about the shaft of the metatarsal without a definite fracture line being discernible. The bone usually shows some rarefaction and resorptive changes, and it is thought that in all of these cases there is a dissolution in the continuity of the shaft even though no fracture line can be seen. This does not seem unreasonable when we realize that some of the very definite fractures are only revealed as such by the aid of a magnifying glass.

Fracture of more than one metatarsal is extremely rare. Figure 4-C illustrates the only case in our series showing a double fracture. Except for the excessive callus formation, which may easily be the result of lack of immobilization, the healing of these spontaneous fractures and the eventual restoration of the bone to its approximately normal

FIG. 1-A

Case 1. Typical tumor-like mass of periosteal proliferation characteristic of march fracture.

FIG. 1-B

Case 1. Roentgenogram of same foot eleven years after Fig. 1-A, showing restoration of normal bone, except for slight cortical thickening.

condition does not differ from the repair of an ordinary fracture.

The treatment of march foot depends upon the period in the disease at which the diagnosis is made.

Recognition of the prodromal symptoms, before fracture has occurred, is important, because at this time the production of the fracture may be prevented by proper prophylactic measures. With rest, hot applications, and relief from weight-bearing, the condition may be arrested during the stage of preliminary swelling, and the foot return to normal after a week or ten days. Toe exercises to restore the flexibility of the anterior metatarsal arch and a proper arch support or strapping of the forefoot should be employed when walking is resumed. Because of economic reasons many patients are unwilling to accept the period of complete rest and in these cases strapping of the forefoot gives the most relief.

After the fracture and callus production have occurred, the treatment will vary according to the severity of the symptoms. Some patients have remarkably little pain and eventually make a complete recovery regardless of what is done for them. Strapping, arch supports, and physiotherapy lessen the pain and shorten the period of disability. Other foot abnormalities which may be present should receive the proper attention.

FIG. 2

Case 6. March fracture, the third metatarsal showing appearance of definite fracture line previous to callus formation.

FIG. 3

Case 2. Unusual type of March fracture showing slight displacement of fragments.

The average disability, where fracture has occurred, is from four to eight weeks. Although suffering varying degrees of pain, very few patients will give up their work, but will continue to limp about, satisfied with the partial relief given by the strapping and arch supports.

The following is a brief report of ten fractures in nine patients:

CASE REPORTS

CASE 1. Miss M. S. I., female, trained nurse, aged thirty-five years, gave a history of pain in both feet extending back for a period of several years. The pain was relieved by flat-foot strapping. Two months before examination patient began having pain in the right foot and the right leg, the pain was worse in the arch of the foot and in the calf of the leg; two weeks prior to examination she began having a dull aching pain in the ball of the foot in the region of the third and fourth metatarsals.

Examination on October 19, 1921, showed longitudinal arches normal, some rigidity of the anterior metatarsal arch, and limitation in flexion of the toes of the right foot, acute pain over dorsum of the third and fourth metatarsals. Head of the third metatarsal was depressed and there was some swelling over the dorsum of the foot.

On October 25, 1921, the patient returned, complaining of increased pain in the foot. Examination showed a firm nodular thickening in the center of the shaft of the third metatarsal. There was a visible and palpable tumor-like nodule in the center of the third metatarsal, no local redness nor heat.

X-ray examination showed a rounded mass of periosteal thickening about the center of the third metatarsal. No definite fracture line could be determined. Subsequent

roentgenograms on November 28, 1921, and on January 4, 1922, showed a gradual condensation of the tumor mass.

The patient's symptoms gradually disappeared and she has had no trouble in the foot since. The last roentgenograms, taken July 9, 1932, showed restoration of practically normal appearance of the bone except for a slight amount of cortical thickening at the site of the previous periosteal proliferation.

CASE 2. Mrs. G. W. A., housewife, aged fifty-six years. In June, 1927, this patient began complaining of pain on dorsum of the left foot just back of the heads of the metatarsal bones. The pain became worse after walking and it improved with rest. There was no history of trauma. The foot swelled after use.

Examination on July 15, 1927, showed an old infectious arthritis of the feet with moderate claw-toe deformity. The longitudinal arches were normal; there were calluses under the heads of the second, third, and fourth metatarsal bones. There was swelling over the dorsum of the foot more marked over the second metatarsal bone with pitting oedema.

Roentgenogram showed a fracture near the proximal end of the second metatarsal with excess callus formation.

The patient was treated by means of strapping and arch supports. The symptoms gradually disappeared, and in November, 1927, she was free of symptoms from the fracture.

CASE 3. J. W. McP., male, physician, aged thirty-five years. Patient stated that he had always had flat feet but that they had never given him any trouble until about six weeks prior to his examination on September 1, 1928, when he bruised the sole of his

FIG. 4-A

Case 4. Preliminary roentgenogram soon after onset of symptoms. No fracture nor periosteal thickening seen.

FIG. 4-B

Case 4. Five weeks later, showing a beginning periosteal thickening of second metatarsal. No definite fracture line seen.

left foot by stepping on a rock when wearing a thin-soled shoe. Since that time the foot had pained him severely when walking, and swelling developed over the dorsum and ball of the foot. There was a very tender spot to palpation over the base of the third metatarsal. He stated that pain in his foot was relieved by rest and that the pain increased when walking.

Examination showed a second degree planus; moderate swelling over the dorsum of the left foot and along the extensor tendons, most marked over the second metatarsal; no tendon nor bone crepitation. Tenderness was quite marked over the base of the second metatarsal, where a firm thickening over the bone could be felt. No other abnormality could be made out in the foot.

X-ray examination showed a fine periosteal proliferation in the upper half of the second metatarsal bone, producing a rounded tumor-like nodule. There was an indefinite fracture line through the shaft of the metatarsal at this point.

The patient was treated with strapping of the forefoot and arch supports, and he remained active in his practice. The symptoms gradually subsided and he has had no pain since.

Case 4. J. F. O., a male, aged sixty, in the insurance business. The patient stated that he had suffered pain in the forefoot for two or three years; the onset occurred rather suddenly without history of injury. About two months prior to his examination on December 11, 1930, he developed pain in the right foot, localized chiefly in the metatarso-

Fig. 4-C

Case 4. Six weeks later, showing condensation of callus and healing of fracture in second metatarsal, also a second spontaneous fracture at distal end of third metatarsal with beginning union.

Fig. 4-D

Case 4. Ten months later, showing healing of both fractures and restoration of practically normal appearance of bone.

phalangeal region. The pain was worse on walking and it improved with rest. The symptoms gradually increased until at the time of his examination he walked with a limp.

Examination of the foot showed considerable swelling and oedema over the dorsum of the forefoot; the skin was slightly reddened, and there was pitting on pressure; there was tenderness over the second metatarsal just proximal to the metatarsophalangeal joint; there was no bone nor tendon crepitation.

Roentgenograms on December 11, 1930, showed the bones of both forefeet negative, no evidence of fracture or periosteal proliferation. It was thought that the patient probably had infectious arthritis, and treatment was instituted for same without improvement.

On January 10, 1931, the swelling over the metatarsal bones had practically disappeared. The patient complained of pain in the anterior metatarsal arch and there was limitation of motion in the toes. Anterior metatarsal strapping was applied.

On January 17, 1931, examination showed recurrence of swelling over the forefoot. There was a localized area of tenderness over the second metatarsal, pain and disability in the foot continuing.

Roentgenograms made on January 17, 1931, showed a beginning periosteal thickening near the center of the second metatarsal; no definite fracture line could be made out. The patient was fitted with arch supports. He returned on February 27, 1931. The swelling and pain in the right foot had gradually decreased, but there was still a painful area in the mid-portion of the second metatarsal and over the distal end of the third metatarsal. The patient had been walking all day with the aid of arch supports and suffered a moderate amount of pain.

Roentgenograms made on February 27, 1931, showed a condensation of callus on the second metatarsal bone and a fracture near the distal end of the third metatarsal with a fairly well condensed and healing callus.

Pain in the foot gradually decreased until in June, 1931, the patient was practically free from symptoms and he had been doing his ordinary work which required him to be on his feet all day. He continued to wear arch supports. This patient has had no symptoms in the opposite foot.

Roentgenograms taken October 26, 1931, showed a complete healing of both fractures with restoration of bone to practically normal appearance.

Case 5. Miss E. E., aged thirty years, a student nurse. Patient stated that she had had no trouble with her feet until three days prior to her examination on December 20, 1930, when she developed pain in the left foot, most marked in the region of the fourth and fifth metatarsals. There was no history of injury. Condition improved with rest but recurred with resumption of duty. Examination of the left foot December 20, 1930, showed marked tenderness over the dorsum of the foot near the distal end of the third metatarsal. There was moderate hallux valgus present, first degree planus. The anterior metatarsal arch was flattened and there was limitation of motion in flexion and extension of the toes with callus formation under the heads of the second and third metatarsals.

The foot was strapped and the patient returned to duty. She was again seen on December 27, 1930, and stated that pain and swelling in the foot had persisted, that a very acute area of tenderness had developed over the shaft of the third metatarsal. Examination showed definite swelling over the metatarsal at this point. Roentgenograms made on December 27, 1930, showed a fracture line across the middle of the shaft of the third metatarsal without displacement of fragments and no callus formation.

Adhesive strapping was continued in this case, and on February 19, 1931, the pain, swelling, and disability in the foot had entirely disappeared. There was no local tenderness over the shaft of the third metatarsal.

Roentgenograms on February 19, 1931, showed that the fracture of the third metatarsal had united with good callus formation. This patient has been free from symptoms in the foot since.

CASE 6. Miss L. M., student nurse, aged twenty-three years. This patient complained of a painful left foot; she did not give a definite history of previous foot trouble, but stated that she had pain at the base of the fourth toe, and that three days prior to her examination on September 15, 1931, swelling developed over the dorsum of the foot. The foot had been strapped without relief. There was no history of trauma.

On examination, September 15, 1931, left foot showed definite swelling over the dorsum of the foot, more marked over the third metatarsal; there was slight increase in local temperature, no redness. The point of maximum tenderness was over the head of the third metatarsal bone, dorsal surface; the longitudinal arch of the foot was normal, and there was limitation of motion in all of the toes.

Roentgenograms on September 15, 1931, showed a fracture of the distal third, third metatarsal bone, no displacement of fragments, no definite formation of callus.

The patient was treated by strapping and arch supports with improvement in symptoms. She did not return for observation and no further follow-up in the case was obtainable.

CASE 7. Miss C. B., aged twenty-two, a student nurse. There was no definite history of previous foot trouble, the patient stated that she had been having pain and swelling over the dorsum of the left foot in the region of the second metatarsal bone for the two weeks previous to examination.

Examination on February 17, 1931, showed moderate swelling on the dorsum of the left foot in the region of the second metatarsal bone, tenderness on plantar surface of foot under the second metatarsal bone; there was a second degree planus of both feet with fixation of the anterior arch and limitation of motion in the toes.

X-ray examination on February 17, 1931, showed a very indistinct but definite fracture line through the second metatarsal just proximal to the head. The foot was strapped with adhesive tape and the patient remained on duty.

On March 20, 1931, the patient returned. The foot had been kept strapped; she had remained on duty since examination, and the pain and swelling had gradually disappeared.

On April 30, 1932, this patient stated that she had had no pain nor disability in the foot for the past year and she had continued on duty, training for a nurse. Examination on this date showed the foot to be normal in appearance and function.

X-ray examination on April 30, 1932, showed a thickening of the cortex of the second metatarsal bone at the site of the previous fracture. The fracture line had entirely disappeared.

CASE 8. Mrs. W. T. O., aged forty-five, housewife. Patient stated that three weeks prior to her examination, on January 11, 1932, she began having pain in the left foot over the metatarsal area; the foot gradually swelled during the day with increase in pain and disability after walking. There had been no redness nor sign of inflammation, the patient had continued to be on her feet although she suffered considerable disability.

Examination of the left foot showed slight swelling over the dorsal surface with tenderness over the upper portion of the shaft of the third metatarsal bone. The longitudinal arch was normal, there was slight hallux valgus present.

Roentgenograms on January 11, 1932, showed slight periosteal thickening at the proximal end of the second metatarsal bone. No definite fracture line was seen.

The foot was strapped and the symptoms gradually disappeared. No further roetgenograms were taken in this case, but at the end of two months she was entirely free from symptoms.

CASE 9. Miss A. M. S., aged twenty-one, a student nurse. Patient stated that she had had no previous history of foot trouble, that two weeks prior to her examination on April 4, 1932, she began having a mild aching pain in the metatarsal region of the right foot and a moderate swelling developed in this area. She remained on duty with only a moderate amount of discomfort.

Examination showed swelling over the dorsum of the right foot in the region of the third metatarsal; there was no redness nor increase in local heat; there was tenderness on pressure over the head of the third metatarsal and along the shaft of the third metatarsal. There was some limitation of motion in flexion and extension of the toes.

X-ray examination on April 30, 1932, showed an indefinite fracture line extending across the third metatarsal about one inch proximal to the head with beginning callus formation.

Subsequent course: The forefoot was strapped with adhesive tape; this was continued for from six to eight weeks when the patient was symptom free. She has had no trouble since.

BIBLIOGRAPHY

1. Bähr, F.: Die Fussgeschwulst und ihre Beziehungen zum Vorderen Frontalgewölbe. Ztschr. f. Orthop. Chir., XXXII, 310, 1913.
2. Von Bergmann, E., von Bruns, P., und Mikulicz, J.: Handbuch der Praktischen Chirurgie. Aufl. 2. Stuttgart, F. Enke, III, 768, 1904.
3. Boisson, A., et Chapotot, E.: Le Pied Forcé; Étude sur la Nature et la Pathogénie des Lésions de l'Avant-Pied, Provoquées par la Marche chez les Fantassins. Arch. de Méd. et de Pharm. Milit., XXXIII, 81, 1899.
4. Breithaupt: Zur Pathologie des Menschlichen Fusses. Med. Ztg., XXIV, 169, 175, 1855.
5. Deutschländer, C.: Ueber Entzündliche Mittelfussgeschwülste. Arch. f. Klin. Chir., CXVIII, 530, 1921.
6. Editorial: Pied Forcé in Soldiers. New York Med. J., LXIX, 783, 1899.
7. Goldman, S. E.: March Foot, With Fracture of Metatarsal Bone. J. Bone and Joint Surg., X, 228, April, 1928.
8. Jansen, Murk: March Foot. J. Bone and Joint Surg., VIII, 262, April, 1926.
9. Maillefert, E.: Ein Fall von Indirectem Bruch eines Mittelfussknochens. Münchener Med. Wchnschr., XLVII, 1237, 1900.
10. Martin, A.: Inflammation Périosto-Arthritique du Pied à la Suite des Marches. Arch. de Méd. et Pharm. Mil., XVIII, 336, 1891.
11. Momburg: Die Entstehungsursache der Fussgeschwulst. Deutsche Ztschr. f. Chir., LXXIII, 425, 1904.
12. Nimier, H.: De l'Entorse Métatarsienne chez les Fantassins. Arch. de Méd. et Pharm. Mil., XXI, 61, 1893.
13. Pauzat, J. E.: De la Périostite Ostéoplasique des Métatarsiens à la Suite de Marches. Arch. de Méd. et Pharm. Mil., X, 337, 1887.
14. Poulet, A.: De l'Ostéopériostite Rhumatismale des Métatarsiens au 3e Régiment de Zouaves. Arch. de Méd. et Pharm. Mil., XII, 245, 1888.
15. Radulesco, A. D.: Néoformation Osseuse Peridiophysiare, Spontanée du 4e Métatarsien. Presse Méd., XXXIV, 37, 1926.
16. Rittershausen: Marschgeschwulst oder sogenanntes Oedem des Mittelfusses. Mil. Wchnbl., 1976, 1894.
17. Schulte: Die sogenannte Fussgeschwulst. Arch. f. Klin. Chir., LV, 872, 1897.
18. Stechow: Fussödem und Röntgenstrahlen. Deutsche Mil.-Ärztl. Ztschr., XXVI, 465, 1897.
19. Straus, F. H.: Marching Fractures of Metatarsal Bones. With a Report of the Pathology. Surg. Gynec. Obstet., LIV, 581, 1932.
20. Thalwitzer: Zur Aetiologie der Fussgeschwulst. Deutsche Mil. Ztschr., XXXI, 435, 1902.
21. Thiele: Ueber Frakturen der Metatarsalknocken durch Indirekte Gewalt (die Ursache der sogenannten Fussgeschwulst). Deutsche Med. Wchnschr., XXV, 158, 1899.
22. Weisbach: Die sogenannte "Fussgeschwulst"—Syndesmitis Metatarsea,—des Infanteristen in Folge von Anstrengenden Märschen. Deutsche Mil. Ztschr., VI, 551, 1877.

THE EFFECT OF TREATMENT AND ERADICATION OF FOCI OF INFECTION IN CHRONIC ARTHRITIS (FOCAL INFECTION)*

BY LEO J. MILTNER, M.D., PEIPING, CHINA, AND JACOB KULOWSKI, M.D., IOWA CITY, IOWA

This study is an attempt to evaluate the associated therapeutic significance of the treatment and, whenever possible, the eradication of foci of infection in chronic arthritis. It is based upon an analysis of 200 cases of chronic arthritis, which were submitted to an exhaustive search for, and the subsequent treatment of, all foci of infection. No cases have been included in which a complete diagnostic and therapeutic régime could not be carried out by the various medical and surgical departments of the hospital. All of these patients have been observed, at intervals of several months following their foci attention, from two to four years.

During the first period of hospitalization, the general condition of the patients demanded other treatment, especially physical rehabilitation and general hygienic measures, including diet and elimination. Consequently, fifty per cent. received some form of orthopaedic mechanical treatment. About twenty-five per cent. were also given dietary and physiotherapeutic care, which was continued at home following discharge from the clinic. Only five per cent. were given any form of medicinal therapy.

From this general preface, the difficulties encountered in attempting a selective clinical evaluation of this one therapeutic factor (foci of infection) are at once apparent. The writers are fully cognizant of this, but the results in this series do indicate the value of the continuance of the eradication of foci of infection, not only in chronic arthritis, but in all those conditions and diseases simulating the rheumatic syndrome. In this clinic this is routinely observed in all cases of chronic arthritis and associated conditions whenever feasible. Chronic arthritis is, therefore, considered to be a focal infection.

That focal infection has changed from a theory to a principle of infection has been due almost entirely to the mass of acquired practical evidence. Certainly, the laboratory background is confusing and less convincing than are the clinical observations. The hypothesis of "elective localization" has overemphasized the bacterial phases of the problem, and has naturally diverted attention from the underlying principles of infection. "When the apparent focus of infection has been removed, there may be an exacerbation of the secondary focus at the time of operation (tonsillectomy, extraction of teeth, *et al.*), or cure of the clinical condition may follow. *This is the criterion on which the principle of focal infection is mainly founded . . .*" (Holman). (The italics are ours.)

* From the Department of Orthopaedic Surgery, State University of Iowa, Service of Dr. Arthur Steindler.

Practically all infections must have a portal of entry with a primary focus from which dissemination may occur. This principle is too broad, and focal infection has come to have a special significance, as distinct from focus of infection. A focus of infection is "a circumscribed area of tissue infected with pathogenic micro-organisms" (Billings). The term focal infection further implies that there has resulted secondary distant or contiguous systemic infection. The former occur by the lymphatics or the blood stream. The joint manifestations in chronic arthritis are then essentially metastatic secondary foci. The ideal eradication of all foci of infection is, therefore, practically impossible as long as there exists any degree of residual joint unsoundness.

"Systemic or general disease due to a local infection is a conception as old as medical knowledge." Mayo quotes Hippocrates as having recorded two cases in which the eradication of foci of infection of the mouth had relieved them of rheumatic troubles of the joints. Benjamin Rush, in 1801, stimulated interest in focal infection when he reported a cure of hip joint disease by the removal of the patient's tonsils. Billings, in 1890, began his classical investigations upon which the principles of focal infection firmly stand, and from which has sprung the key to the understanding of innumerable systemic diseases.

For purposes of convenience and clarity, this series of cases has been divided clinically into the two classic types—chronic atrophic arthritis and chronic hypertrophic arthritis—according to the classification adopted by the American Committee for the Control of Rheumatism.*

The *hypertrophic form* (osteo-arthritis, degenerative arthritis) is characterized pathologically by lipping, fibrillation, and splitting of the cartilage, and erosion by attrition, sclerosis, eburnation, and grooving of the underlying bone. There is no general proliferation of the synovial membrane nor marked evidences of inflammatory infiltration. Clinically, it is characterized by its occurrence usually in older, well nourished, stocky individuals of good general health. There is some degree of pain and stiffness of the joints, grating and crepitation, and deformity due to bony outgrowths. Limitation of motion is due to mechanical bony blocks.

The *atrophic form* (rheumatoid arthritis, infectious arthritis, proliferative arthritis, etc.) is characterized pathologically by inflammatory proliferation and infiltration of the synovial membrane, atrophic bony changes, erosion of the articular cartilage independent of attritional influences (at periphery), and fibrous adhesions or ankylosis. The clinical features include its occurrence in younger asthenic individuals whose general condition is not robust, the evidence of a more or less subacute inflammation, pain and limitation of motion of the joints and a tendency to contracture formation, periarticular tissue involvement with fusiform swelling, and a marked tendency to fibrous or bony ankylosis.

* There may be no sharp dividing line between the two groups, but pathologically and clinically there are usually present certain salient features by which they are differentiated.

CLINICAL ANALYSIS OF END RESULTS

I. *Chronic Atrophic Arthritis* (100 cases)

The favorable reactions to foci attention were so striking in the younger patients that a division into two main age groups seemed advisable (See Tables I and II). The first group represents all cases ranging from infancy to sixteen years of age inclusive.

A. Children and adolescents, thirty-seven cases.

The arthritides are so commonly observed in the young that particular emphasis is warranted. The disease was polyarticular as a rule and usually involved one or more of the larger joints. There were five patients with advanced Still's disease, who exhibited enlargement of the liver, spleen, and lymphatic nodes, and were markedly emaciated. In these the effects of foci eradication were in no way comparable to the results obtained in earlier cases which did not have such systemic complications. Otherwise, the symptoms and findings resembled the usual adult types of the disease.

The foci of infection situations were almost exclusively found in the upper respiratory tract (Table I). Seventy-three per cent. (27 cases) of this entire group (Tables I and II) were apparently cured following the eradication of foci of infection; sixteen per cent. (6 cases) were markedly improved, and eleven per cent. (4 cases) showed no improvement, the latter all being cases of Still's disease. The associated pediatric and orthopaedic care consisted largely of dietary management, along with rest and immobilization of the affected joints. The search for foci was sometimes difficult and tedious and required a number of examinations as well as repeated attentions by those who had had special training in otolaryngology of children, as the following case report demonstrates.

The patient was a female child two years of age, and seen August 1925. The disability resulted from painful polyarthritis of one year's duration. The joint involvement followed a severe diarrhoea, and was accompanied by fever. Since the onset there

TABLE I

SITUATIONS OF FOCI OF INFECTION IN 100 CASES OF CHRONIC ATROPHIC ARTHRITIS

37 patients up to 16 years of age inclusive	Situation	63 patients over 16 years of age (adults)
No foci	Dental	22 foci
24	Tonsillar	16
9	Paranasal sinuses	14
No foci	Gastro-intestinal	13
No foci	Genito-urinary	12
6	Ear and mastoid	1

Of the entire group only fifteen cases had more than one focus per case present; the remaining eighty-five cases had only one demonstrable focus of infection per case that required treatment. Such findings do much to simplify the problem of foci attention. The rule should be to treat every definite focus of infection found in a case of chronic atrophic arthritis, whenever possible. It will be noted that the foci are more wide-spread in the adult group.

had been several exacerbations of acute joint pain and swelling, the last attack being associated with an acute upper respiratory infection. On admission to the hospital, the child was markedly emaciated and had multiple joint enlargements and mild deformities. Special examination revealed chronic disease of the tonsils and adenoids. Significant laboratory findings were the 30,400 white blood count, and the pus cells, and one plus albumin in the urine. The tonsils and adenoids were removed, following which the temperature returned to normal, and much of the pain and swelling in the joints disappeared. The tendency to loose stools disappeared and the pyelitis cleared up. The weight gradually increased during the next two weeks. The patient was discharged from the hospital, but returned four months later. At that time, examination showed that the patient had improved considerably, but the joints soon became subacutely involved and remained thus for two months. The nasal sinuses were thought to be the seat of chronic infection, which examination under anaesthesia showed to be the ethmoids. The ethmoidal labyrinths were curetted out from each side. The operator reported marked disease of the ethmoidal labyrinths with thickened membranes and hypertrophic softened bone. Because of insufficient improvement, following this radical procedure, the patient was operated upon again and, at this time, macroscopic pus was also found in both maxillary sinuses. The predominating organisms in the pus obtained from the sinuses were long chain streptococci. Because of the age of the patient, it was necessary to use ethylen anaesthesia in order to perform the repeated irrigations of the sinuses. Three weeks following the irrigation treatment, definite improvement in the joints was noted. The patient looked greatly improved and had gained considerable weight. The patient had several mild exacerbations of fever with mild reinfection of the ethmoidal sinuses, and, with each flare-up of infection, the joint symptoms became more noticeable. The close relation between infection of the sinuses and the presence of joint symptoms, pyelitis, and malnutrition was very constant and was very striking to all of those concerned in the care of the patient.

B. Adults (over sixteen years of age), sixty-three cases.

The foci of infection were notably more wide-spread, and were situated, in their order of frequency, in and about the teeth, tonsils, nasal accessory sinuses, gastro-intestinal and genito-urinary systems, and the mastoids (Table I).

TABLE II

END RESULTS FOLLOWING THE TREATMENT AND ERADICATION OF FOCI OF INFECTION IN 100 CASES OF CHRONIC ATROPHIC ARTHRITIS

Age Group	Apparent Cure	Marked Improvement	No Improvement
A. Up to 16 years of age inclusive.....	73 per cent. (27 cases)	16 per cent. (6 cases)	11 per cent. (4 cases)
B. Over 16 years of age (adults).....	15 per cent. (10 cases)	58 per cent. (36 cases)	27 per cent. (17 cases)
Influence of duration of the disease in the adult group of cases			
1. Under 2 years.....	8 cases	26 cases	8 cases
2. Over 2 years.....	2 cases	10 cases	9 cases

The tabulation shows that the fundamental elements appear to be the duration of the disease and the age of the patient, which determine the favorable reaction to the eradication of foci of infection.

TABLE III

SITUATION OF FOCI OF INFECTION IN 100 CASES OF CHRONIC HYPERTROPHIC ARTHRITIS, AND END RESULTS FOLLOWING THEIR TREATMENT AND ERADICATION

1. Single focus group	Dental	43 cases
	Tonsillar	12 cases
	Paranasal sinuses	9 cases
	Gastro-intestinal	8 cases
	Genito-urinary	6 cases
	Mastoid	2 cases
	Total	80 cases
2. Multiple foci	Dental, tonsillar, sinus	10 cases
	Gastro-intestinal, genito-urinary	8 cases
	Dental, gastro-intestinal	2 cases
	Total	20 cases
3. Results	Apparent cure	0 cases
	Marked improvement	9 cases
	No improvement	91 cases

Eradication of foci of infection had little or no favorable influence upon the condition.

It was apparent that the favorable response to foci attention in adults depended, in part, upon the duration of the disease and the joint symptoms (Table II). The sooner after the onset of the illness that the foci were treated, the better were the results obtained. In those obstinate cases of long duration, it was assumed that the secondary joint foci themselves were actively operative in the disease. Of the ten adult cases cured, eight were under two years' duration. Twenty-six of the thirty-six that were markedly improved belonged to this same group. Seventeen cases were apparently not influenced at all by the eradication of the foci of infection.

II. *Chronic Hypertrophic Arthritis* (100 cases)

It was evident that, in the average case, the hypertrophic changes had been present over long periods. In most instances, the onset of the painful symptoms was traced back to mechanical injuries. The ages varied from seventeen to seventy-six years, *most of them having been observed after middle age.* Approximately seventy-five per cent. of the patients were of the laboring class. All of these cases were searched for foci of infection as carefully as were those of the atrophic group.

It was learned that ninety-five per cent. of the patients showed demonstrable foci of infection (Table III). Among the older individuals, the dental foci predominated (sixty-one per cent.). Tonsillar, sinus, gastro-intestinal, and genito-urinary foci were discovered and treated in over half of the cases. Chronic mastoid infections were found in two cases. As far as could be determined clinically, the duration of symptoms did not materially influence the end results in this group. In a few instances, there was definite flare-up of pain in several weeks following the

surgical treatment of the focus, indicating a definite relationship. This period of aggravation was succeeded usually by gradual subsidence of the symptoms, and a return of the joint condition to the pre-treatment stage. In Table III, nine cases are listed as showing improvement.

DISCUSSION

The fact that chronic arthritis permits of a relatively simple classification, both clinically and pathologically, indicates the modern tendency to regard its diversified manifestations as chiefly differences of degree. These variations are dependent upon a variety of causes. The condition may be considered, in a general way, as an end-result process, particularly the hypertrophic type, which is usually indicative of long duration. The tissues involved are those of low differentiation, and it is not unusual to find both types of reaction overlapping in the same patient or, what is more convincing, in the same joint. There need be no sharp dividing line between the two great classes. The atrophic and the hypertrophic forms are expressions of opposite ends of the same scale of a single disease. Circulatory disturbances are at the basis of all these infections. The difference in blood supply of the bones and joints at different ages, the vitality of the tissues during the initial invasion, the alterations produced by injuries, and the invasive power of the bacteria may account for most of the infections coming from a focus elsewhere. Practically all of Koch's postulates have been experimentally fulfilled to prove that at least some forms of chronic non-suppurative arthritis are due to bacteria.

It is practically impossible to state definitely by what criteria one may establish the causal relation of a focus of infection in a given case of chronic arthritis. This is further complicated by the fact that a focus must not necessarily be active objectively or subjectively. Many healthy individuals harbor some focus or foci of infection. No less confusing are the secondary interrelationships of multiple foci that may be found in a single individual. It is, of course, necessary first to find the foci. A most diligent and persistent search is often warranted. They are more readily recognized in the superficial subepithelial situations,—as the tonsils. In the gastro-intestinal and, more particularly, the genito-urinary systems the entire field of medicine and surgery may well be challenged. Repeated examinations of the paranasal sinuses and the prostate will often be rewarded. After the foci have been found, their importance in a given case may be determined by such procedures as blood and local bacterial cultures, testing the patient's sensitiveness to the isolated bacteria, and by complement-fixation tests. The clinical evaluation is by far the most important one from a practical standpoint. Finally it may be axiomatically stated that all definite foci that are discovered in a case of chronic arthritis should be treated or eradicated whenever possible, and if the patient's condition permits. The resultant improvement of the general condition which usually follows this is sufficient indication.

In a general way active primary foci of infection are usually above the

vocal cords, while the main secondary foci are found in the tissues below them; the intestinal tract, then, naturally receives the great majority of organisms from above. The foci encountered in this series of cases include the following situations,—tonsils, teeth, paranasal sinuses, ear and its appendages, prostate, intestinal and genito-urinary tracts and associated structures. Most of these have received the bulk of attention in the literature. However, the sinuses have been sufficiently recognized as sources of foci of infection only very recently.

Sinus disease occurs with considerable frequency in certain parts of the country. In some of our cases, especially in younger individuals, the improvement following the treatment of sinusitis has been convincingly demonstrated. We should remember that chronic sinusitis is frequently secondary to chronic tonsillitis, and that the former must be eradicated to insure the best results. As a practical aid in the diagnosis of sinus foci in children, it is essential to note that developmentally the antra are present very early; the sphenoids appear at the age of three, and the frontal sinuses at eight.

In no situation is repeated examination so necessary as in the prostate. It has been shown recently that such foci of infection are very common in adults,—over seventy per cent. according to one author.

It is a significant finding in this series that about eighty per cent. of the cases harbored only one demonstrable focus. This simplified the problem of eradication, but it is felt that some foci were missed, and might account for the less striking results in the adult groups.

The foci in children were more readily recognized, and were certainly less wide-spread and diversified. In many of them the initial joint symptoms could be traced back to the causal acute or chronic focus or foci. In these cases, particularly, the results were sometimes almost spectacularly favorable, following the eradication of the foci. The favorable reaction to foci treatment was most convincing on the whole in those patients under sixteen years of age. The negative influences obtained in the hypertrophic forms may be explained, in part at least, by such factors as age, degenerative changes, duration, and the intrinsic constant injuries these joints are actively subjected to incident to the anatomical deformities present. The term "cure" as used in this paper, indicates a return to the normal clinical state in children. In the adult group it means the same, or arrest of the disease and complete relief of the symptoms.

The joint, especially the synovial membrane of the atrophic variety, must be considered as a secondary focus of infection. Of the seventy or more synovectomies performed in this clinic, the great majority were in cases of atrophic arthritis. Pathological studies clearly indicate the chronic inflammatory nature of the reaction in the tissues excised. Local and systemic relief following this operation is evident. Steindler, in speaking of synovectomy, states, "It is necessary that the disease be localized in one or a few joints only and that the systemic character of the disease has come to an end. Above all things the joint must be in a state of quiescence."

This naturally raises the question of when to operate upon foci of infection. In this clinic it is preferred that the disease should be more or less quiescent before any foci are surgically attacked. This precaution should be observed particularly when the focus is frankly suppurative. Conservative treatment of the focus may be instituted as soon as the diagnosis is made. Some authors believe that the reaction of exacerbation of the joint symptoms that frequently follows the removal of foci acts favorably because of the febrile reaction; but there is also the danger of further dissemination of bacteria to new secondary situations.

Before drawing definite conclusions, it is desirable to emphasize in a general way the systemic and particularly the orthopaedic aspects of the treatment in these cases. Although the generalized nature of chronic arthritis was recognized by orthopaedic surgeons, who were faced originally by its wide-spread deformities, and who urged that the treatment should proceed upon broad general principles, they have realized, nevertheless, that preventive and corrective measures against deformities remain as yet of primary importance. Prevention of deformity is combatted especially in the active stages. When the disease has become quiescent, function is restored by means of appliances and surgery. The local orthopaedic treatment is suggested by the underlying predominant features of the case,—whether they are atrophic or hypertrophic in character.

In the atrophic type the general body mechanics and systems are below par. Improvement may be expected from positional rest periods, exercises, temporary supports, and general hygienic measures.

In the hypertrophic variety the remodeling is obviously harder; but there is less need for general rehabilitation, and mechanical support gives relief.

Because of the basic circulatory deficiency of the joints in chronic arthritis, all measures which tend to increase the blood supply—such as heat, massage, voluntary exercise, and general physiotherapy—are beneficial and sometimes curative in both types. The great comfort derived from the intelligent use of physiotherapy alone indicates its general application in almost every case of chronic arthritis.

Intelligent physiotherapy demands that all such measures be carried out in moderation to avoid fatigue, mechanical strain, or trauma. Further dissemination may be set up by the over-zealous laying on of hands. Many of the older patients are generally run down, and prolonged enthusiastic treatment is more depressing than stimulating. The state of the joints is also an important criterion. Periodic exacerbations of low-grade temperature have been observed in some instances from faulty physiotherapy.

During the active stages of the disease, prevention of deformity and the maintenance of joint motion is accomplished by traction, intermittent use of splints and appliances, and voluntary motion. When ankylosis is imminent, then it should be allowed to become so only in the optimum

functional position. This is especially a threat in the atrophic type and should be a guide in the amount of motion prescribed in such cases. The surgical procedures in the residual stages include aspiration, synovectomy, correction of deformities by closed or open methods, and joint reconstruction by arthroplasty in part or entirely.

The dietary régime followed in these cases is based upon that of Pemberton, and also emphasizes the anticonstipation elements required. High or low caloric values were instituted as seemed necessary.

Elimination was encouraged by colonic irrigations, mineral oil, and mild catharsis.

CONCLUSIONS

Great emphasis has been placed upon the eradication of foci of infection in the treatment of this series of chronic arthritis cases. The results are at least twenty-five per cent. better than in a similar group in which foci attention was not stressed.

The eradication of foci of infection is of primary importance in children particularly. The results here are most convincing, probably because anaphylaxis is more marked in them. In adults suffering from the atrophic type of chronic arthritis, the beneficial results from foci attention will depend upon the age of the patient and the duration of the disease. The interrelation of foci of infection and chronic atrophic arthritis is almost self evident in many instances. It has been observed, in this clinic, that the focus eradication—for instance, where a focus had caused pain in an apparently quiescent contracted arthritic knee that was undergoing correction by the turnbuckle-cast method—resulted in the cessation of pain and the completion of the correction that would otherwise have been indefinitely postponed or even prohibited.

Foci attention in the hypertrophic types did not materially influence the end results.

Certain foci situations have been emphasized.

Rationalization in the treatment of chronic arthritis demands that the entire field of medical and associated sciences be enlisted.

The orthopaedic aspects of the treatment of chronic arthritis remain as yet of primary importance, but the value of foci attention as one of the associated therapeutic measures should be recognized.

BIBLIOGRAPHY

Adams, R.: Treatise on Rheumatic Gout, or Chronic Arthritis of All the Joints. London, J. Churchill, 1857.

Allison, N., and Ghormley, R. K.: Diagnosis in Joint Disease. New York, William Wood and Co., 1931.

Alvarez, W. C.: Lessons to be Learned from the Results of Tonsillectomies in Adult Life. Observations in More than Three Hundred Cases. J. Am. Med. Assn., LXXX, 1513, 1923.

Arbuckle, M. F.: Systemic Manifestations of Suppurative Disease in Paranasal Sinuses. J. Am. Med. Assn., LXXXI, 741, 1923.

Billings, F.: Focal Infection. New York, D. Appleton and Co.,

Burbank, R.: The Etiology and Treatment of Chronic Arthritis. J. Am. Med. Assn., XCIX, 1489, 1932.

Burbank, R., and Hadjopoulos, L. G.: Serologic Significance of Streptococci in Arthritis and Allied Conditions. J. Am. Med. Assn., LXXXIV, 637, 1925.

Byfield, A. H.: Systemic Manifestations of Chronic Nasal Sinus Infection in Childhood. J. Am. Med. Assn., LXXI, 511, 1918.

Cecil, R. L., and Archer, B. H.: Classification and Treatment of Chronic Arthritis. J. Am. Med. Assn., LXXXVII, 741, 1926.

Cecil, R. L., Nicholls, E. E., and Stainsby, W. J.: The Bacteriology of the Blood and Joints in Chronic Infectious Arthritis. Arch. Int. Med., XLIII, 571, 1929.

The Etiology of Rheumatoid Arthritis. Am. J. Med. Sciences, CLXXXI, 12, 1931.

Colyer, S.: Chronic Infection of the Jaws. New York, The Macmillan Co., 1926.

Digby, K. H.: Immunity in Health; the Function of the Tonsils and Other Subepithelial Lymphatic Glands in the Bodily Economy. New York, Oxford University Press, 1919.

Duke, W. W.: Oral Sepsis in Its Relationship to Systemic Disease. St. Louis, C. V. Mosby Co., 1918.

Hadjopoulos, L. G., and Burbank, R.: The Correlation of Experimental Streptococcic Arthritis in Rabbits with Chronic Rheumatoid Arthritis. J. Bone and Joint Surg., XIV, 471, July 1932.

Holman, W. L.: Focal Infection and "Elective Localization"; Critical Review. Arch. Path. and Lab. Med., V, 68, 1928.

Jeans, P. C.: Paranasal Sinusitis in Infants and in Young Children. Am. J. Dis. Child., XXXII, 40, 1926.

Jones, E.: Synovectomy of the Knee Joint in Chronic Arthritis. J. Am. Med. Assn., LXXXI, 1579, 1923.

Kaiser, A. D.: The Relation of the Tonsils to Acute Rheumatism During Childhood; a Study of Four Hundred and Thirty-Nine Children with Acute Rheumatism. Am. J. Dis. Child., XXXVII, 559, 1929.

Keilty, R. A.: The Tonsils as Foci of Infection. J. Med. Research, XLII, 315, 1921.

Kistner, F. B.: Chronic Nonpurulent Sinusitis and Its Clinical Significance. Ann. Otol. Rhin. and Laryng., XXXVIII, 795, 1929.

Kolmer, J. A.: Focal Infection from the Laboratory Standpoint. J. Am. Med. Assn., LXXXVII, 824, 1926.

Kulowski, J.: Flexion Contracture of the Knee. The Mechanics of the Muscular Contracture and the Turnbuckle Cast Method of Treatment; with a Review of Fifty-Five Cases. J. Bone and Joint Surg., XIV, 618, July 1932.

Lawson, L. J.: The Rôle of the Nasal Accessory Sinus Membrane in Systemic Infections and Toxemias. Ann. Otol. Rhin. and Laryng., XXXIX, 159, 1930.

Mackenty, J. E.: Upper Respiratory Focal Infections in Some of Their Regional and General Manifestations. Bull. New York Acad. Med., VII, 71, 1931.

Mayo, C. H.: Focal Infection of Dental Origin. Dental Cosmos, LXIV, 1206, 1922.

Moench, L. M.: The Relationship of Chronic Endocervicitis to Focal Infection with Special Reference to Chronic Arthritis. J. Lab. and Clin. Med., IX, 289, 1924.

Mutch, N.: Alimentary Infections in Chronic Arthritis. Lancet, II, 1266, 1921.

Nichols, E. H., and Richardson, F. L.: Arthritis Deformans. J. Med. Research, XXI, 149, 1909.

Pavey-Smith, A. B.: Tonsillectomy in Chronic Arthritis. A Report of Two Hundred Cases Carried out at the Royal Bath Hospital, Harrogate. Lancet, I, 170, 1929.

Pelouze, P. S.: The Medical Importance of Focal Infective Prostatitis. Am. J. Med. Sciences, CLXXXIV, 254, 1932.

Pemberton, R.: Developments in the Problem of Arthritis. J. Am. Med. Assn., XCVI, 33, 1931.

PEMBERTON, R.: Arthritis and Rheumatoid Conditions: Their Nature and Treatment. Philadelphia, Lea and Febiger, 1929.

PEMBERTON, R., CAJORI, F. A., AND CROUTER, C. Y.: Influence of Focal Infection and the Pathology of Arthritis. J. Am. Med. Assn., LXXXV, 1793, 1925.

The Influence of Focal Infection and the Pathology of Arthritis. Results of Experiments: Second Paper. J. Am. Med. Assn., LXXXVII, 2148, 1926.

POYNTON, F. J., AND PAINE, A.: A Further Contribution to the Study of Rheumatism. The Experimental Production of Appendicitis by the Intravenous Inoculation of the Diplococcus. Proc. Roy. Soc. Med., V (Path. Sec.), 18, 1911–1912.

PRICE, W. A.: Some Systemic Expressions of Dental Infections. Ann. Clin. Med., IV, 943, 1925–1926.

RHEUMATISM PRIMER: Prepared and privately printed for the medical profession by a Sub-Committee of the American Committee for the Control of Rheumatism.

RICHARDS, J. H.: Bacteremia Following Irritation of Foci of Infection. J. Am. Med. Assn., XCIX, 1496, 1932.

Bacteriologic Studies in Chronic Arthritis and Chorea. J. Bacteriol., V, 511, 1920.

ROSENOW, E. C.: Focal Infection and Elective Localization of Bacteria in Appendicitis, Ulcer of the Stomach, Cholecystitis, and Pancreatitis. Surg. Gynec. Obstet., XXXIII, 19, 1921.

Elective Localization of Streptococci. J. Am. Med. Assn., LXV, 1687, 1915.

RUSH, B.: Medical Inquiries and Observations Upon the Diseases of the Mind. Ed. 2. Philadelphia, J. Richardson, I, 199, 1818. *In* Oral Sepsis in Its Relationship to Systemic Disease. By W. W. Duke. St. Louis, C. V. Mosby Co., 1918.

STEINDLER, A.: Operative Orthopedics. New York, D. Appleton and Co., 1925.

Synovectomy and Fat Pad Removal in the Knee. J. Am. Med. Assn., LXXXIV, 16, 1925.

SWAIM, L. T., AND KUHNS, J. G.: The Prevention of Deformities in Chronic Arthritis. III. The Lower Extremity. J. Am. Med. Assn., XCIV, 1743, 1930.

WALTHER, H. W. E.: Prostatitis: Its Rôle in Focal Infection. New Orleans Med. and Surg. J., LXXVIII, 493, 1926.

WILENSKY, A. O.: The Mechanism of Acute Bacterial Infection of a Joint. Arch. Surg., XIII, 895, 1926.

ANTERIOR DISLOCATION OF OS LUNATUM

BY G. W. N. EGGERS, B.A., M.D., F.A.C.S., GALVESTON, TEXAS
University of Texas, Department of Surgery

A. EXPERIMENTAL DISLOCATION

The os lunatum, that crescentic, elusive, carpal bone, lies in the proximal row between the navicular and os triquetrum. The dorsal ligament is smaller than the volar attachment to the radio-carpal ligament (Fig. 1).

FIG. 1

Longitudinal section of wrist, showing curvature of head of capitate and anterior and posterior (smaller) ligaments of os lunatum.

The motions of the radio-ulnar-carpal articulations are extension, flexion, abduction, adduction, and circumduction. Rotation of the true wrist (intercarpal) is said not to occur. However, there is motion in the carpal articulations, gliding in type, and rotation must be present to some degree in the capitate-lunate ball and socket type of articulation. The center of rotary motion is through the capitate and lunate which form the main support in that region; therefore, these bones must receive the greater amount of thrust and rotation in abnormal traumatic forces applied to the wrist joint. Figure 2 represents the normal wrist in extension. Note the radius principally in its contact with two bones, the lunate and the navicular. The navicular should be emphasized especially.

Dislocation of the lunate occurs in hyperextension of the wrist joint and pronation of the forearm. The forces applied are hyperextension, a thrust downward, and so called "squeezing out" of the bone, rupturing the posterior and interosseous ligaments. The bone, therefore, rotates distally and anteriorly; and its position is such that the distal articular surface faces anteriorly, and the proximal articular surface, posteriorly. The volar radiocarpal ligament is often injured,

FIG. 2

Hyperextension of hand. Note os lunatum and navicular articulations.

FIG. 3

Anterior dislocation of os lunatum. In this case the bone had perforated the volar carpal ligament.

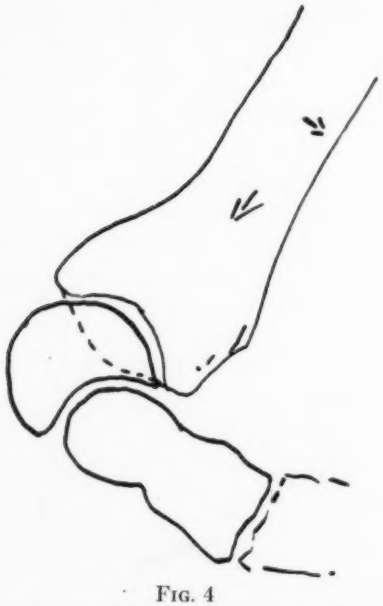

FIG. 4

Distal force causes radius to impinge on capitate as does the hyperextension, rather than slip past it.

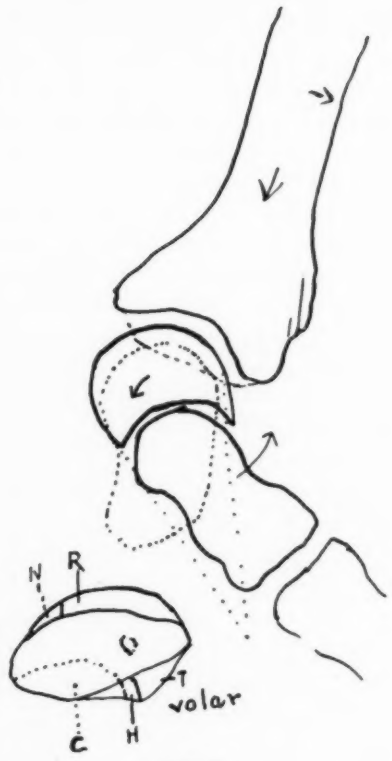

FIG. 5

Rotation by distal radial pressure ("squeezing out") in the circle, an arc of which the curvature of the os lunatum represents, was not possible.

and the bone may entirely perforate this ligament. (In one case shown in Figure 3 this condition was verified at operation). The presence of the bone on the anterior carpal surface prevents flexion at the wrist almost completely and is the important clinical fact in these cases, often not observed.

The etiology of this dislocation has been indefinite, or merely a statement such as "squeezing out". In Figure 4 the hyperextension, with pulling of the radius distally, muscularly, or by external force along the radial axis, is considered. The force to drive the lunate anteriorly is directed against the capitate rather than the lunate. The navicular receives that anterior force. Moreover the posterior ligament of the lunate must rupture. The anterior volar ligament is forcing the lunate into the concave articulation of the radius. To displace the lunate in the cadaver by this method failed.

The second consideration is squeezing the lunate out of its articulation (Fig. 5). The curvature of the lunate, when a force is applied in extension, must be applied by the close-fitting radius, and the natural movement of such force would be to rotate the bone so that the proximal articular surface would move anteriorly. But the pressure is not applied to the lunate only, the navicular sharing in this pressure. It is difficult to understand just how this bone would be so displaced. The anterior

ligament is found intact in the anterior dislocation, and this acts as direct counter pressure full against such a movement. The lunate, separated from both anterior and posterior ligaments, failed to respond when the manoeuver described was performed on the experimental specimens.

Before considering the next manoeuver, it should be noted that the two movements previously described are based on hyperextension, combined with pressure excited in line of the radius distally. The frequency of this indirect trauma to the wrist is shown by the great number of fractures of the distal end of the radius. To dislocate the bone, the methods here described take for granted an extremely elastic volar ligament. This would certainly be likely in children with their youthful ligaments. However, practically all of the lunate dislocations are in adults in whom the elasticity of the ligament is less. It is my belief that the dislocation is more complicated than the simple descriptions given.

It is necessary to note certain facts in describing the next possibility of dislocating the lunate. The capitate and lunate form the bony column to receive distal thrusts. The lunate and capitate form an almost ball and socket joint, at which any intercarpal rotation may occur, granting the interosseous ligaments restrict it. If by force these ligaments should break, then intercarpal rotation would tend to occur at the lunate-capitate articulation. The lunate is firmly held by the radius, inducing the greatest motion at the lunate-capitate joint. The triquetrum is held firmly in place by the flexor carpi ulnaris through the pisiform. In hyperextension of the wrist the flexor carpi ulnaris tends to broaden the interval between the capitate triquetrum and hamate. The arc of curvature of the capitate is greater posteriorly, which may allow it to slip past the lunate easily.

FIG. 6

Forearm in extreme medial rotation; the pisiform and triquetrum removed. Volar carpal ligament and posterior ligament of os lunatum divided. Note how os lunatum slips past head of capitate in interval described.

With these facts in mind, the mechanics of the dislocation would be hyperextension of the wrist with hand fixed; then medial rotation of the forearm, which continues until pronation reaches the maximum of radio-ulnar rotation; the medial rotation continues; then the intercarpal rotation starts between the capitate and lunate. As this is forced, the interosseous ligaments are stretched or broken, the lunate rotates medially until it passes the anterior edge of the capitate which slips proximal to it (Fig. 6). The lunate has a wedge-shaped area on the dorsal surface directed toward the hamate, which tends to slip between the hamate and capitate; for this interval is increased by the medial rotation opposed by the flexor carpi ulnaris. As the abnormal force subsides, lateral rotation of the forearm occurs in hyperextension, and the flexor muscles pull the carpal bones proximally. By this manoeuver, the lunate is now forcefully ejected anteriorly; breaks the weaker posterior ligament; and is rotated proximally and anteriorly into the usual position of dislocation by its anterior ligament. By dividing the posterior and interosseous ligaments, the dislocation can be accomplished on the cadaver by the application of the manoeuvers described. (The manoeuver may be described by fixing the forearm and rotating the hand, in which case the directions of rotation are reversed.)

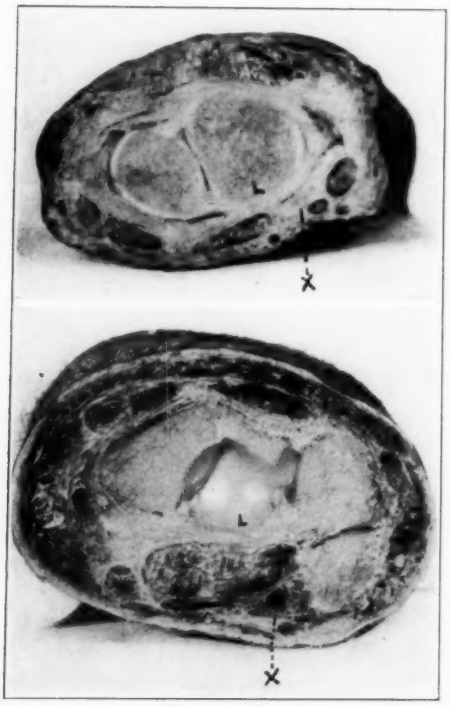

FIG. 7

Cross sections of wrist. *X*—The fibrous tissue layer between the flexor carpi ulnaris and flexor group of hand. *L*—Os lunatum.

While it is realized that there is no limit to the combination of abnormal physical forces in trauma, nevertheless this explanation of dislocation is offered. Surely its rarity is somewhat in keeping with the experimental findings on the cadaver.

B. SURGICAL APPROACH

The diagnosis is not difficult if the x-ray is used. Clinically the flexor tendons are prominent; there are pain and tenderness in the wrist joint and particularly inability to actively or passively flex the wrist. True, some of these dislocations are diagnosed as sprains, but that is another topic. The treatment is reduction of the dislocation or removal of the lunate. Reduction of the dislocation has been considered in the articles by Davis [20] and Böhler [6]. However, it seems that reduction is sound judgment,

because the anterior ligament certainly is usually sufficiently attached to furnish a satisfactory blood supply.

To remove the bone several surgical approaches are possible. The usual posterior approach is such as to be extremely difficult and easily allows fragments of the bone to remain. The anterior mid-line approach is through the flexor tendon sheaths and near the median nerve. The objection here is tendon-sheath damage and adhesions to the skin of the tendon-traversed areas.

A third possibility is to approach the bone lateral or medial to the flexor tendon sheath. However, since the lunate is medial, this eliminates the lateral approach.

This medial approach is found to be satisfactory. Figure 7, a cross section of the wrist, shows the fibrous tissue pathway leading from the surface of the wrist, between the flexor tendons and the flexor carpi ulnaris with the ulnar nerve and artery. This leads down to the anterior carpal ligament; incision of the ligament is necessary for removal of the bone.

The method of this approach, with asepsis given all proper consideration is as follows: Incision is made two and one-half inches long just lateral to the flexor carpi ulnaris, starting one-half inch distal to the pisiform bone and extending proximally. The skin is incised; sometimes a small superficial vein needs ligation. Then by blunt dissection the ulnar artery and nerve are easily identified and retracted medially (the flexor carpi ulnaris prevents trauma by stretching). The flexor tendons are lifted anteriorly and laterally and the volar carpal ligament is visible. The bone is in the distal end of the incision. The ligament is divided transversely and retracted, and the lunate removed. Since the anterior ligament (the anterior surface of the dislocated bone is rotated cephalward) holds the lunate, division releases it readily for removal. After being released the carpal ligament is readily approximated and, when traction is removed, all structures assume their anatomical position. Closure of the skin is now necessary. A light plaster splint is placed dorsally for comfort.

REFERENCES

1. Pfab, B., und Zöllner, F.: Zur Pathologie der Handgelenkverletzungen. Navicularefrakturen, bzw. Pseudarthrosen mit Cystenbildung. Lunatumluxationem. Lunatummalacien. Deutsche Ztschr. f. Chir., CCXXXIII, 355, 1931.
2. Ach, C.: Die Behandlung der Mondbeinverrenkungen. Zentralbl. f. Chir., LVII, 1217, 1930.
3. Jones, R. W.: Carpal Semilunar Dislocations and Other Wrist Dislocations with Associated Nerve Lesions. Proc. Roy. Soc. Med. (Sect. Orthop.), XXII, 43, 1929.
4. Keenan, C. B., and Wilkie, A. L.: Dislocation of Semilunar Bone of Wrist. Canadian Med. Assn. J., XX, 639, 1929.
5. Beck, A.: Ein Weiterer Fall von Blutiger Einrenkung einer Mondbeinluxation. Zentralbl. f. Chir., LVI, 649, 1929.
6. Böhler, L.: Behandlung Frischer und Veralteter Mondbeinverrenkungen. Zentralbl. f. Chir., LVI, 646, 1929.
7. Jaroschy, W., und Gregora, H. V.: Zur Frage der Unblutigen Behandlung der

Perilunären Dorsalluxation der Hand (Mondbeinverrenkung). Med. Klin., XXIV, 1340, 1928.

8. McBride, E. D.: Dislocation of the Semilunar Bone. Neurospastic Fixation of the Hand: A Deformity Characteristic of the Injury. Arch. Surg., XIV, 584, 1927.
9. Farr, C. E.: Dislocation of the Carpal Semilunar Bone. Ann. Surg., LXXXIV, 112, 1926.
10. McBride, E. D.: Dislocation of the Carpal Semilunar Bone. A Report of Eight Cases. Med. J. and Rec., CXXIV, 82, 1926.
11. Ujma, A.: Über Endausgänge Nicht Operierter Lunatumluxationen. Deutsche Ztschr. f. Chir., CXCVI, 288, 1926.
12. Wittek, A.: Ueber die Behandlung der Mondbeinverrenkung. Wiener Klin. Wchnschr., XXXIX, 1097, 1926.
13. Noon, C.: Dislocation of the Semilunar Bone. With Notes of a Case. Lancet, I, 432, 1925.
14. Conwell, H. E.: Closed Reduction of Acute Dislocations of the Semilunar Carpal Bone. Ann. Surg., LXXXII, 289, 1925.
15. Adams, J. D.: Displacement of the Semilunar Carpal Bone. An Analysis of Twelve Cases. J. Bone and Joint Surg., VII, 665, July, 1925.
16. Brandt, G.: Über den Entstehungs Mechanismus der Sogenannten Isolierten Mondbeinluxation. Deutsche Ztschr. f. Chir., CXC, 396, 1925.
17. Lediard, H. A.: Dislocation of Semilunar Bone. Edinburgh Med. J., XXX, 244, 1923.
18. Clairmont, P., und Schinz, H. R.: Zur Konservativen Behandlung der Mondbeinverrenkung. Zentralbl. f. Chir., L, 1386, 1923.
19. Sonntag: Ein Weiterer Fall von Operierter Mondbeinverrenkung. Deutsche Ztschr. f. Chir., CLXXVI, 289, 1923.
20. Davis, G. G.: Treatment of Dislocated Semilunar Carpal Bones. Surg. Gynec. Obstet., XXXVII, 225, 1923.
21. Foss, A. R., and Cranmer, R. R.: Dislocated Semilunar Bone. Minnesota Med., V, 484, 1922.
22. Golden, W. W.: Dislocation of the Semilunar Bone: Report of Case in Which Reduction Was Successful. J. Am. Med. Assn., LXXVI, 446, 1921.
23. Kleinberg, S.: Dislocation of the Carpal Scaphoid and Semilunar Bones. J. Am. Med. Assn., LXXIV, 312, 1920.
24. Hamill, R. C.: Forward Dislocation of Semilunar Bone; Undiagnosed. Internat. Clin., III, 124, 1920.
25. Cohn, I.: Dislocations of the Semilunar Carpal Bone. Ann. Surg., LXXIII, 621, 1921.
26. Cunningham, D. J.: Manual of Practical Anatomy. Ed. 8. Vol. I. Superior and Inferior Extremities. London, Oxford University Press, 1930.

THE TREATMENT OF OSTEOMYELITIS

BY CHARLES LYLE HAWK, M.D., M.SC., LOS ANGELES, CALIFORNIA

The classical description of inflammation characterizes it as presenting calor, dolor, rubor, and tumor. This is true of soft tissue where these features are present, but bone tissue is rigid, and the tumor or swelling is necessarily absent, although the heat, pain, and redness may be present. The inflammation causes an exudate, forming a defensive barrier, which requires room for expansion so that the exudate can accumulate the defensive materials,—therefore the swelling. When the process develops in bone tissue, the necessary exudate causes the barrier to be forced back into the rigid channels. It is readily seen that in an acute process rapid and often unabated destruction of bone takes place. Trendell says that bacteria of bone infection are always virulent. In case the organism becomes attenuated and the process is halted, and nature is left unaided, a chronic bone abscess continues to discharge for years, for no other reason than because of its location in rigid tissue which will not expand and allow of defensive and reparative efforts sufficient for healing.

Inflammation is described by Adami as the condition into which tissues enter as a reaction to irritation. This reaction in bone infection means efforts at destroying the bacteria, neutralizing the bacterial toxins, removing the necrosed débris, and repairing the tissue defect. The purpose of treatment must be to aid nature in fulfilling these functions. Any form of treatment that stimulates the exudate and neutralizes the agencies which are harmful to repair is to be desired. This implies more than simple protection to the wound. It means a stimulant to the exudative process and a provision for free and open drainage and hygienic measures that will augment the blood supply to the part. The late William Baer was the author of successful mechanical hyperaemia, but some form of chemical hyperaemia is desired in bone infections. We, therefore, use the principle of osmosis to hasten the healing of bone wounds and to care for the infection present. Some solution with high osmotic action, whose solute has a high valence with active ionization for the precipitation of colloids and destruction of bacteria, is desired. It should be non-toxic to viable tissue and not too irritating to sensory nerves.

According to Mathews [1] the necessary concentration to precipitate colloids is 21.3 for calcium chlorid, 34.1 for magnesium sulphate and 16.4 for magnesium chlorid. These are bivalent salts, while sodium chlorid is monovalent and requires a relative concentration of 1680. According to A. A. Green [2] sodium sulphate is second in the order of decreasing precipitating power among a list of salts given, magnesium sulphate is fifth, and sodium chlorid is seventh. The precipitating power of a salt varies with the valence and the readiness with which it ionizes. As the ions appear to be electrical charges associated with the valence of the salt,

bivalent salts have a much higher precipitating power than the monovalent, the trivalent being still more powerful. Also, the heavier the metal, the greater the precipitating power. The specific gravity of sodium is 0.972, of magnesium, 1.75. Whetham computed that an ion with two or more electrical charges attached—*i. e.*, a bivalent or trivalent ion—has far greater chances of coming into contact with the colloid and precipitating it. The ions alter the surface contact of the colloids with water and cause them to accumulate into clumps and precipitate. Magnesium ionizes better than sodium, though the latter has greater internal energy as a metal. Also, the ionization of the sulphate radical is greater than that of the chlorid radical. Magnesium sulphate was, therefore, chosen as the salt most desirable for our purpose.

The formation of exudates is accomplished largely by the action of osmosis, and the equilibrium is governed by the relative concentration of the fluids inside and outside of the capillaries. These vessels ordinarily allow only the serum globulins, crystalloids, and smaller structures to pass through the walls. Injury will allow the albumins to pass, and sometimes in such quantities as to render the concentration outside equal to the plasma albumin.[3] The capillary walls are rendered more pervious by inflammation in direct ratio to the intensity of the infection. This seems to be nature's way of increasing the exudate, in the absence of artificial means. But by adding to this the powerful effects of a high osmotic fluid, the exudate is much increased and the granulations spring up most abundantly. The forceful exosmotic action eliminates the toxins and markedly reduces the number of bacteria present. For repair of bone tissue, the same process is followed as occurs in the formation of membranous bone in the foetus. The type cell is the fibroblast, and the proliferation of this cell, together with endothelial cells, forms very vascular connective tissue, which becomes osteoid in character. Trabeculae of this tissue thicken and fuse and receive deposits of lime salts.[4] It is obvious that such procedures are augmented by increasing the exosmotic flow and are only hindered by unabsorbable packs filling the defect, thus preventing adequate drainage,—especially when the dressing is left in indefinitely, causing a back pressure of the accumulated pus.

So many of our osteomyelitic cases are either old cases with labyrinthean sinuses or cases where, because of anatomical design, the process cannot be wholly eliminated mechanically, that one must resort to physicochemical means to secure the desired result. It is obvious, therefore, that to hasten the healing of a wound and to diminish absorption, it should be filled with a solution, capable of exerting a high osmotic pressure, which will accelerate the formation of an exudate and also exert antiseptic action on the infection, without injury to the viable tissues. Exosmosis, and the precipitating action of ionized salts on the bacteria, will accomplish this end.

Much has been said about the drainage of infected tissues. Dead protoplasm is acid, and, if the wound is left filled with an acid débris, it

causes a diminution of oxygen tension in the granulation tissue cells and excites the autolytic enzymes in the cells to dissolve the protoplasm. Acid causes swelling of tissue cells and this has the effect of pushing deeper into the bone canals the barriers that have been set up. In the practice of treating the wound by plugging with vaselin gauze, it has been urged that drainage is of prime importance. But for adequate drainage to be secured in a rigid bone wound plugged with vaselin—a substance non-miscible with water—and the part then enclosed in a plaster case for an indefinite period, is more than the writer's imagination can encompass! We, therefore, advocate frequent dressings, in order to keep the wound clean and to replenish the exosmotic fluids. In case bacteriophage may be considered to play a part in those forms of treatment which involve plugging the bone with a non-absorbable substance, it is well to bear in mind the fact that phage respires, during its destruction of bacteria, absorbing oxygen and emitting carbon dioxid. Even in test-tubes the bacteria are lysed in from three to five hours, when the broth culture is shaken to increase the oxygen tension; the unshaken tubes require from eight to twelve hours.[5] Truly, with the wound plugged, little respiration can take place. Phage is often found in a wound, but is usually not lytic to the wound bacteria,—living there in symbiosis.[6] Purulent material, exudate, blood, and diluted serum are all inhibitory to the lytic action of phage, even in dilutions of 1:1000.[7] These findings necessitate continuous cleansing of the wound, if phage is to play any part in the sterilization and healing. Kreuscher and Hueper tell us that the healing of bone is delayed in direct ratio to the infection present.[8]

The procedure which the author follows is first to evacuate all the dead and pus-infiltrated bone, regardless of its extent, the only limiting bounds being the epiphyseal discs in the young, and the sparing of sufficient bone in the shaft to maintain strength. Unless the whole bone is destroyed, one can usually provide ample drainage by chiselling away only one-third of the cross section of the shaft. It is not necessary to make an extensive saucerization; but the outer width should be greater than the basal diameter, so that the latter will close first by granulations. The time of operation is—as the late J. B. Murphy said—as soon as osteomyelitis is diagnosed.[9] With the high-osmotic dressing, the surface fluids are immediately drawn into the wound, instead of being allowed to be absorbed by plugging the cavity with a non-absorbable substance. It is well, in acute cases, to swab the wound with tincture of iodin. The surface of fractures and of chiselled bone dies, even in closed fractures, and one must expect to find thin layers of dead bone floating on the granulations after one or two weeks; so a mild cauterization of the denuded areas with iodin will do no harm. After the mechanical work is done and the wound treated as described above, it is packed with gauze, well impregnated with a paste made of one part glycerol and two parts magnesium sulphate. The gauze serves as a wick, when the paste is thinned by absorption of blood and exudate. The wound does not have to be

completely dried, but the spurters should be closed with bone wax. The paste should be prepared beforehand with incorporated layers of gauze and the whole autoclaved. In case the wound is small, it should be filled with paste and the gauze laid on top. An ample amount of the paste is placed over the gauze covering the wound, and the whole enclosed in an oiled-silk dressing, which should be snugly bandaged to the limb. There will be some oozing which will wash the wound and bring blood to the part, while the paste solution prevents any reabsorption.

In case one is unable to remove all the diseased tissue from an old case, or in an acute fulminating one, the dressing should be changed in from four to seven days, depending upon the temperature. As soon as the temperature goes up, it means absorption with the dilution of the paste to a hypotonic solution. The amount of oozing following operation will influence this very markedly and, therefore, it is best to wrap the limb well with oiled silk and, if necessary, to cement the edges with collodion to hold the fluids until thrombosis of the vessels takes place. A hypodermic should be given before the first and sometimes before the second dressing, because the removal of any gauze incorporated in granulations at this time is very painful. The pus is removed by pouring peroxid of hydrogen into the cavity. This has the highest interfascial tension of any non-metallic pure fluid at room temperature,[10] and this is ideal for removing pus and débris without injury to the granulations. The foam and remaining liquid is removed by a pledget of absorbent cotton, not gauze. The cavity is again packed with the paste and gauze as before and the same dressing applied. In comparatively clean cases the dressings should be changed twice weekly. In badly infected cavities it should be changed every second day. There is practically no odor unless the lesion is in a place where the dead tissue could not be completely evacuated, as in osteomyelitis of the upper end of the tibia. All the diseased bone that can be removed safely without danger of involving the joint should be evacuated, and the subsequent treatment trusted to remove the remainder. The granulations will be so abundant that pieces of non-viable bone will be seen floating near the surface.

In regard to immobilization—a point which has been stressed so vigorously by Orr [11]—we have emphasized that bone tissue is rigid, and any infection therein is splinted by nature to the *n*th degree, the only alteration that an enclosing plaster case can accomplish is to render the circulation more sluggish, and thus to interfere with healing. We advise getting the patient on his feet as soon as he has recovered from the mechanical work in the operating room, providing enough bone has been left to support the limb. For this reason the author advises making the excavation long and narrow, first, to retain strength in the shaft and, second, because the cavity will heal more quickly if the granulating sides are not separated too far. Bone is viable tissue, and living tissue increases its vitality with use. Not all of the bone is diseased, and the resistance of the viable part to the infection will be raised by use. Using

FIG. 1
Case 1. Before operation.

FIG. 2
Case 1. Six weeks after operation.

a bone increases the blood flow, mobilizes calcium, and stimulates the part to meet the demands placed upon it. The x-ray shows absorption of calcium after one week in a limb that is immobilized for any cause, and this proves the delicate balance, to which bone is sensitive, between use and non-use. It has been found by animal experimentation that ligating return veins in cases of arterial damage lessens the frequency of gangrene in the limb. Intracapillary tension is necessary for proper nutrition and the use of a limb in a dependent position increases both the blood pressure and the hydrostatic capillary pressure. When one views a patient lying in bed week after week, with the involved part enclosed in a cast, and absorbing putrefactive products from the wound, with a sluggish circulation from no exercise, one is not surprised to see him sallow and toxic in appearance, and what little appetite he may have diminished by a foul stench! The author has seen this picture only too often; the wonder is that the patient gets well at all.

If the soft tissues about the bone are involved, as may happen in a gunshot wound, the musculature must be kept quiet until ample soft-tissue

FIG. 3

Case 2. Lateral view twenty-three days after operation.

barriers are formed. In such a case some exercising apparatus should be rigged to the bed for the use of the sound limbs, to maintain the general vitality and force of heart action. Also, in all cases, healing is assisted by dry heat treatments. It is reported that protoplasmic activities are increased two or three times by a rise of ten degrees in temperature. The efficacy of thermal therapy is unquestioned.

Two typical cases are presented.

CASE 1. B. R., white, male, aged forty-five. Patient entered the hospital in November 1928, with a compound, comminuted fracture of the right leg. In March 1930 the roentgenogram showed healing of the fractured bones with some residual infection and a draining sinus. Patient was first seen by the writer September 18, 1931, with a small sinus leading into the bone at the site of the fracture. At operation, September 19, 1931, a small sequestrum was removed and a quarter inch of sclerosed bone was removed from around the sinus. The cavity was filled with magnesium sulphate paste and gauze, with more paste placed on top and wrapped in oiled-silk dressing. Dressing was changed on fifth day and bi-weekly thereafter. Patient was allowed up on crutches six days after operation. Wound was healed six weeks later.

FIG. 4

Case 2. Anteroposterior view twenty-three days after operation.

CASE 2. M. R., white, male, aged twenty-three. He had accidentally shot himself in the thigh in 1929 and had improved until May 1930 when, while at work, he accidentally injured himself at the site of the old injury. He was operated on September 6, 1930, and again in February, 1931, and the wound was "packed with paraffin and vaselin gauze". He was again operated on in June 1931, and an "Orr pack with cast from groin to toes" applied. Patient was first seen by the author on August 28, 1931, at which time the roentgenogram showed "a large part of the shaft of the femur consistent with osteomyelitis". There was a discharging sinus in the site of the old scar, eight inches long, on the outer aspect of the thigh.

FIG. 5

Case 2. Showing lateral view of femur fifteen weeks after operation.

At operation September 5, 1931, the entire outer one-third of the cortex of the femur was removed for a distance of eight inches. The cavity was then packed with magnesium sulphate and glycerin paste and gauze and the limb enclosed in a water-proof covering and bandage applied. The patient was last seen on January 11, 1932, in the Out-Patient Department, at which time the wound was almost healed. This patient had had two flare-ups from the infection in the soft tissues which confined him to bed for short intervals. This case is reported to illustrate the rapid regeneration of bone in the extensive cavity which was infected and sclerosed in obscure areas. We believe that the physical exercise practised by this patient helped to clear up the old latent soft-tissue infection as well as to stimulate bone growth.

The early exercises must not be mild, else the soft-tissue barriers will be broken down and the infection spread, as is well known.

FIG. 6

Case 2. Anteroposterior view fifteen weeks after operation.

BIBLIOGRAPHY

1. MATHEWS, A. P.: Physiological Chemistry. Ed. 3. New York, William Wood and Co., p. 224, 1920.
2. GREEN, A. A.: Studies in the Physical Chemistry of the Proteins. VIII. The Solubility of Hemoglobin in Concentrated Salt Solutions. A Study of the Salting Out of Proteins. J. Biol. Chem., XCIII, 495, 1931.
3. GOVAERTS, P.: *In* Quantitative Clinical Chemistry by J. P. Peters, and D. D. Van Slyke. Baltimore, Williams and Wilkins Co., Vol. I, 1931.
4. MALLORY, F. B.: The Principles of Pathologic Histology. Philadelphia, W. B. Saunders Co., p. 75, 1925.

5. Eaton, M. D., Jr.: A Quantitative Study of the Respiration of Staphylococcus Cultures Lysed by Bacteriophage. J. Bact., XXI, 143, 1931.
6. Albee, F. H., and Patterson, M. B.: The Bacteriophage in Surgery. Ann. Surg., XCI, 855, 1930.
7. Applebaum, M., and MacNeal, W. J.: Influence of Pus and Blood on Action of Bacteriophage. J. Infect. Dis., XLIX, 225, 1931.
8. Kreuscher, P. H., and Hueper, W. C.: The Histology of the Postoperative Healing Process in Chronic Osteomyelitis and Its Prognostication from Biopsy Sections. J. Bone and Joint Surg., XII, 541, July, 1930.
9. Murphy, J. B.: The Clinics of John B. Murphy. Philadelphia, W. B. Saunders Co., V, 119, 1916.
10. Taylor, H. S. (Editor): A Treatise on Physical Chemistry. A Cooperative Effort by a Group of Physical Chemists. Ed. 2. New York, D. Van Nostrand, II, 1627, 1931.
11. Orr, H. W.: The Treatment of Osteomyelitis and Other Infected Wounds by Drainage and Rest. Surg. Gynec. Obstet., XLV, 446, 1927.

THE RÔLE OF SURGICAL MAGGOTS IN THE DISINFECTION OF OSTEOMYELITIS AND OTHER INFECTED WOUNDS *

BY WILLIAM ROBINSON, PH.D., AND VERNON H. NORWOOD, M.D.,
WASHINGTON, D. C.

One of the characteristics of the Baer maggot treatment is a marked reduction in the infection of the wound. Baer [1,2] noted an unusual decline in the number of bacteria present in the wound when maggots were used, and he described maggots as a "viable antiseptic". Confirmation of his results has appeared in the extensive literature on the subject of the maggot treatment.

An investigation has been made of the manner in which disinfection is brought about. A discussion of results follows, with details of the experiments omitted in this article.

DESTRUCTION OF BACTERIA BY DIGESTION

When maggots are implanted in an infected wound they feed upon the necrotic and purulent materials present and, at the same time, take up large numbers of bacteria. The digestion of such bacteria is one means by which maggots could reduce wound infection. To determine the fate of ingested bacteria, observations were made of their progress through the alimentary tract. Maggots which had fed within osteomyelitis wounds for one to two days were dissected aseptically. Portions of the intestine and the tubular "stomach" were removed and cultured bacteriologically.

In all of the specimens dissected abundant bacterial growth was obtained in cultures from the "fore-stomach". On the other hand, no growth whatever was observed in any of the cultures from the intestine. An intermediate area called the "hind-stomach" showed slight growth in one-third of the cases.

A progressive destruction of the ingested bacteria was, therefore, found to take place in the alimentary canal. The sterility of the intestine is evidence that the bacteria are destroyed in the stomach.

In a study of the nutrition of blow-fly larvae, Hobson [3] found proteolytic enzymes in the fore and hind portions of the stomach, activity being especially marked in the hind section. The digestive effect of these enzymes may explain the destruction of bacteria in the stomach. It is significant that the hind stomach, where the decrease in numbers of bacteria is most evident, is the section with greatest enzymic activity.

Some tests were therefore made of the ability of these enzymes to destroy such bacteria as streptococcus hemolyticus and staphylococcus

* Contribution from the Division of Insects Affecting Man and Animals, Bureau of Entomology, United States Department of Agriculture, Washington, D. C., and the Pathological Laboratory of the Church Home and Infirmary, Baltimore, Md.

aureus, commonly found in the osteomyelitis wound. The digestive enzymes of the maggots were obtained by macerating sterile maggot tissue, consisting principally of alimentary tract. This was then inoculated under various conditions with the bacteria mentioned. All subcultures showed abundant growth; and no evidence was obtained, even with the lightest inoculations and the longest periods of contact, of any destructive effect. In view of the fact that such bacteria are destroyed within the maggot, the negative results obtained may be due to the death of the enzyme-secreting cells during maceration.

These results differ from those reported by Livingston[4], who stated that "paste made from the dead bodies (of maggots) is also effective as a curative agent"; and from the results reported by Livingston and Prince[5] as follows: "filtered, uncontaminated products derived from the bodies of larvae in culture, when brought into contact with pyogenic organisms in petri dishes, destroyed the cultures". Also, in his report[4] of one hundred cases of infected wounds in which he used the maggot treatment, Livingston observes that, "If the wound was clean and the discharge moderate or slight after the third application (of maggots), the use of live maggots was discontinued, and gauze packs saturated with active principle were introduced daily until healing was accomplished, or until the discharge again increased in amount. If the discharge again became profuse, maggots were reintroduced from one to three times." Under this method of treatment any healing effect of an "active principle" or maggot extract is not readily evident.

REMOVAL OF NECROTIC TISSUE AN AID TO WOUND DISINFECTION

It is recognized that necrotic tissue remaining in the wound favors increased infection as well as absorption of toxic substances. Myers and Czaja[6] have shown the difficulty or impossibility of complete elimination of all such tissue surgically. Furthermore, additional necrosis frequently occurs.

Maggots feed voraciously upon the devitalized and purulent materials which accumulate within the wound, and are usually found in such areas. The amount of necrotic material which each implantation of maggots is capable of removing is surprisingly large. An average implantation will consume as much as ten to fifteen grams. This is augmented by further implantations every four or five days. Maggots, therefore, aid in cleaning up the wound by penetrating necrotic areas, suitably opened up, and feeding therein, thus making the condition of the wound less suitable for bacterial growth.

SECRETIONS A FACTOR IN DISINFECTION OF THE WOUND

During maggot treatment the wound is stimulated to secrete a thin, serous discharge in comparatively large quantities. This is heavily contaminated and carries off numbers of the pathogenic organisms of the

wound. Such drainage, which continues as long as maggots are present, becomes a significant factor in hastening disinfection of the wound.

LIVING MAGGOTS APPEAR NECESSARY IN TREATMENT

The effects obtained in this investigation have all been the result of the direct activities of living maggots. Mixtures of macerated maggot tissue gave negative results in cultures. The removal of necrotic tissue, which is important in treatment, also requires living maggots. The presence of active maggots in the wound, therefore, appears to be a prime requisite in treatment.

This differs from the view-point expressed by Livingston and Prince[5] who reported that a maggot extract was "in itself a curative agent". The use of such an extract in wounds, whereby maggots could be eliminated, would be very desirable. However, data sufficient to prove the effectiveness of these mixtures have not yet been given.

DEVELOPMENT OF GRANULATION TISSUE

The abundant growth of granulation within the wound is one of the outstanding characteristics of the maggot treatment. This growth is sometimes regarded as the result of a stimulation by maggots. In view of the present investigation, it seems possible that the increased growth may not be altogether due to actual stimulation. Where maggots are not used in treatment of chronic osteomyelitis, there is likely to be a greater amount of necrotic tissue present and a higher infection. Such conditions may produce sufficient toxins to prevent the natural growth of granulation. Under the maggot treatment, with its more rapid cleaning up of the wound, the tissue may be free to grow spontaneously at its normal rate; and, in contrast with the usual rate, may appear to be a stimulation.

SUMMARY

When used in infected wounds, the surgical maggots are able to hasten disinfection. A study has been made of the means by which the destruction of bacteria has been brought about. Maggots ingest bacteria in large numbers in feeding upon the necrotic tissues of the wound. Cultures of aseptic dissections of the alimentary tract of maggots showed an abundance of bacteria in the fore-stomach, decreasing numbers in the hind-stomach, and apparently a total disappearance of the bacteria in the intestine. This indicates that ingested bacteria are destroyed in passing through the alimentary tract.

To determine whether or not destruction is caused by digestion, tests were made of the action of digestive enzymes of maggots upon streptococcus hemolyticus and staphylococcus aureus. The enzymes were obtained by maceration of sterile maggot tissue. Results were negative in all cases. This is probably due to death of enzyme-secreting cells during maceration. Livingston and Prince report positive results and

state that applications of maggot extract were effective as a curative agent. The data, however, do not make clear how the healing effect obtained was due to maggot extract. Repetition of our tests confirm our negative results.

Maggots feed upon the necrotic and purulent materials within the wound. They thus aid in cleaning up the wound and making its condition less suitable for bacterial growth.

Drainage from the wound is stimulated under maggot treatment. The excessive discharge, which is heavily contaminated with bacteria, assists in wound disinfection.

This investigation indicates that the effects obtained in the maggot treatment of infected wounds are due to the action of living maggots in the wound, and that living maggots can not be eliminated in treatment.

The increased growth of granulation tissue within the wound and its relation to maggot activities is discussed.

REFERENCES

1. Baer, W. S.: Sacro-Iliac Joint; Arthritis Deformans; Viable Antiseptic in Chronic Osteomyelitis. Proc. Internat. Assembly, Inter-State Post-Grad. Med. Assn., North America (1929), V, 371, 1930.
2. Baer, W. S.: The Treatment of Chronic Osteomyelitis with the Maggot (Larva of the Blow-Fly). J. Bone and Joint Surg., XIII, 438, July, 1931.
3. Hobson, R. P.: Studies on the Nutrition of Blow-Fly Larvae: I. Structure and Function of the Alimentary Tract. J. Exper. Biol., VIII, 109, 1931.
4. Livingston, S. K.: Maggots in the Treatment of Chronic Osteomyelitis. Infected Wounds, and Compound Fractures. An Analysis Based on the Treatment of One Hundred Cases with a Preliminary Report on the Isolation and Use of the Active Principle. Surg. Gynec. Obstet., LIV, 702, 1932.
5. Livingston, S. K., and Prince, L. H.: The Treatment of Chronic Osteomyelitis. With Special Reference to the Use of the Maggot Active Principle. J. Am. Med. Assn., XCVIII, 1143, 1932.
6. Myers, J., and Czaja, L. M.: The Maggot Treatment of Osteomyelitis. Illinois Med. J., LX, 124, 1931.

ASEPTIC NECROSIS OF THE HEAD OF THE FEMUR FOLLOWING TRAUMATIC DISLOCATION OF THE HIP JOINT

Case Report and Experimental Studies *

BY WILLIAM J. STEWART, M.D.**, CHICAGO, ILLINOIS

Traumatic dislocation of the hip in adults is a not infrequent accident. In the great majority of instances, the hip joint returns to normal within a few weeks after reduction of the dislocation and there are no subsequent changes in the head of the femur. That quite startling changes may occur after dislocation is illustrated by the following case reported from the University of Chicago Clinics.

CASE REPORT

R. B., male, aged twenty-two, was admitted to the University of Chicago Clinics complaining of pain in the right hip, associated with a limp and inability to bear weight upon the right leg.

Twelve months before his admission on December 27, 1930, the patient was in an automobile accident from which he suffered a simple dislocation of the right hip, as shown by a roentgenogram (Fig. 1) and minor bruises and lacerations. The dislocation was reduced within a few hours and the leg put in a spica cast. A roentgenogram through the cast confirmed the reduction. The patient thought that during the first week or so, "he might have had some slight fever", but he was uncertain about this. A roentgenogram taken one month after the accident showed no change in the joint (Fig. 2). After six weeks, the cast was removed and he was permitted to walk with crutches. He gradually increased his activity and, after three months, walked with a cane. The range of motion in the hip was restricted, but it gradually improved and the pain lessened. After five months, the pain and stiffness gradually increased and two months later he had to resort to the use of two canes in walking.

Figure 1, a roentgenogram taken December 27, 1930, shows the head of the femur riding above the acetabulum. The head is smooth and of even density. There are no fracture lines in the neck or upper third of the femur and the acetabulum appears normal. A film taken immediately after reduction showed the head of the femur in the acetabulum and normal relationships of the hip joint reestablished.

Figure 2, a roentgenogram one month later, January 26, 1931, shows the head of the femur in the acetabulum. There are two lines in the course of the weight-bearing portion of the acetabulum which are apparently cast by different portions of the curved articular cortex. There is slight clouding of the lower part of the acetabulum.

Nine and one-half months after the dislocation, September 10, 1931, a roentgenogram (Fig. 3) was taken which shows disappearance of the cartilage space and some of the substance of the head in the weight-bearing portion of the joint. There is some reduction in density of the remaining weight-bearing portion of the head. There is a cloudy increase in density in the region of the mesial portion of the head. The head is flattened and irregular. There are two cloudy, oval shadows in the region of the capsule just below the superior acetabular margin. There is regional bone atrophy.

* From the Division of Orthopaedic Surgery, Department of Surgery, University of Chicago. This work was done under a grant from the Douglas Smith Foundation for Medical Research of the University of Chicago.

** Thesis submitted to the Faculty of Orthopaedics of the Graduate School of Medicine of the University of Pennsylvania in partial fulfilment of the requirements for the degree of Master of Medical Science [M.Sc. (Med.)] for graduate work in Orthopaedics.

FIG. 1

Before reduction.

The patient continued to walk with canes, and another roentgenogram (Fig. 4) was taken ten and three-quarters months after the injury, which shows the loss of the cartilage space and the disappearance of the substance of the head and weight-bearing portion of the joint previously noted. The two oval shadows in the superior portion of the joint capsule are more pronounced and resemble new bone formation. In addition, there is a similar process in the inferior portion of the capsule. There is increased density of the mesial portion of the head, but the loss of density of the weight-bearing portion of the head is not so pronounced.

One year after the injury, when the patient was examined, he complained of considerable pain on walking, which was accomplished with the aid of two canes. Physical examination revealed a large, muscular, well developed man of twenty-two, not acutely ill. Regional examination was essentially negative aside from the right hip and leg.

There was definite atrophy of the muscles of the entire right leg. Hip flexion was limited to about forty-five degrees. The thigh was abducted about ten degrees. Abduction, adduction, and rotation were markedly limited. Forced movements of the hip were somewhat painful. There was no tenderness on pressure over the joint. A roentgenogram (Fig. 5) December 26, 1931, showed no marked change from the film made one month before.

The diagnosis at this time was as follows:

1. Old traumatic dislocation of the right hip, reduced.
2. Rupture of the ligamentum teres and interference with the blood supply of the head of the femur.

3. Aseptic necrosis of the head of the femur with subsequent breaking down of the weight-bearing portion of the head from usage.
4. Ossification of the capsule of the joint.
5. Destructive traumatic arthritis of the acetabulum.

Treatment:

Under ethylene anaesthesia, the hip was abducted about forty-five degrees and a body and right thigh spica cast was applied. Two months later the cast was removed. Motion at this time was painful and limited to ten degrees' abduction, ten degrees' adduction, twenty degrees' flexion, and ten degrees' rotation.

The patient was confined to bed and traction was applied to the leg for two hours twice a day with resultant relief of pain. After three weeks of this treatment, motion was limited to ten degrees' flexion, ten degrees' rotation, five degrees' abduction, and five degrees' adduction. A roentgenogram was taken at this time, March 18, 1932 (Fig. 6). The density of the mesial portion of the head was very marked and there was also increased density of the acetabulum above the weight-bearing portion of the head.

FIG. 2

One month after reduction, through the cast.

FIG. 3

Nine and one-half months after reduction, showing beginning breaking down of the head.

FIG. 4

Eleven months after reduction, showing ossification of the capsule and more breaking down of the weight-bearing portion.

FIG. 6

Fifteen months after reduction, showing increased ossification of the capsule and rounding of the head.

FIG. 5

One year after reduction.

FIG. 7

Sixteen and one-half months after reduction, showing marked ossification of the capsule and transformation of the head, with no cartilage space.

The head appeared more round and smooth than in the previous film, and, while there was no demonstrable cartilage space, or shadow of articular cortex on the weight-bearing portion of the head, the outline of the head was fairly well defined. The new bone formation in the capsule at the upper portion of the joint was well marked. There was marked regional bone atrophy.

The patient was allowed to walk with crutches for six weeks, during which time the pain in the hip gradually decreased while the range of motion increased to thirty degrees of flexion. A roentgenogram (Fig. 7) taken at this time (May 9, 1931), showed apparent shortening of the neck, which is largely due to external rotation of the femur, and irregular increased density of that part of the femoral head in actual contact with the acetabulum. There was marked increased density of the acetabulum in the weight-bearing portion, while the lower portion showed rarefaction. The ossification of the capsule had increased so that it resembled a bone shelf thrown out from the acetabulum above the

TABLE I

NECROPSY FINDINGS

Days	Ligamentum Teres	Contour of Head	Other Changes
Series 1-a. Division of Ligamentum Teres, Young Rabbits.			
7	Ununited	No changes	No changes
15	Reattached	No changes	No changes
30	Ununited	No changes	No changes
45	Reattached	No changes	No changes
60	Ununited	No changes	No changes
90	Ununited	Flattened	Cartilage thin. Neck shortened
120	Reattached		Adhesions in acetabulum
Series 2-a. Division of Ligamentum Teres, Old Rabbits.			
7	Ununited	No changes	No changes
15	Ununited	No changes	None
30	Ununited	Normal appearing	Neck absorbed so head can be moved on shaft although still attached
45	Reattached	No changes	None
60		Absorbed	Infected, neck absorbed
90	Ununited	Flattened	Cartilage thin, neck shortened
120	Ununited	Flattened	Articular cartilage thin, neck short
Series 3-a. Division of Ligamentum Teres, Old Dogs.			
45	Reattached		Neck accidentally fractured after removal
90	Ununited	No change	Cartilage a little thin
120	Reattached	No change	None

Ligamentum Teres	Contour of Head	Other Changes
Series 1-b. Division of Ligamentum Teres, Circumcision of Neck, of Young Rabbits.		
Ununited	No changes	No changes
Ununited	No changes	No changes
Reattached	No changes	No changes
Ununited	Smaller	Cartilage thin
Ununited	Smaller	Cartilage thin, adhesions fill acetabulum
		Infected, head and neck destroyed
	Destroyed	Infected, part of neck remained
Series 2-b. Division of Ligamentum Teres, Circumcision of Neck, of Old Rabbits.		
Reattached	No changes	No changes
Ununited	No changes	None
Ununited	Anaemic	Neck anaemic
Reattached	No changes	None
Ununited	Smaller, edges eroded	Cartilage thin, neck shortened
	Destroyed	Infected. Stump of neck articulating with acetabulum
Reattached	Little smaller	None
Series 3-b. Division of Ligamentum Teres, Circumcision of Neck, Old Dogs.		
Reattached	Little smaller	None
Ununited	Flattened	Hip dislocated, capsule adherent to superior portion of articular cartilage, cartilage thin and eroded, under surface of neck eroded and acetabulum partially filled with granulations
Ununited	Markedly flattened	Cartilage eroded, neck shortened, some granulation tissue in lower part of acetabulum

FIG. 8

Roentgenograms of Series 1-a. (Normal femora on right.)

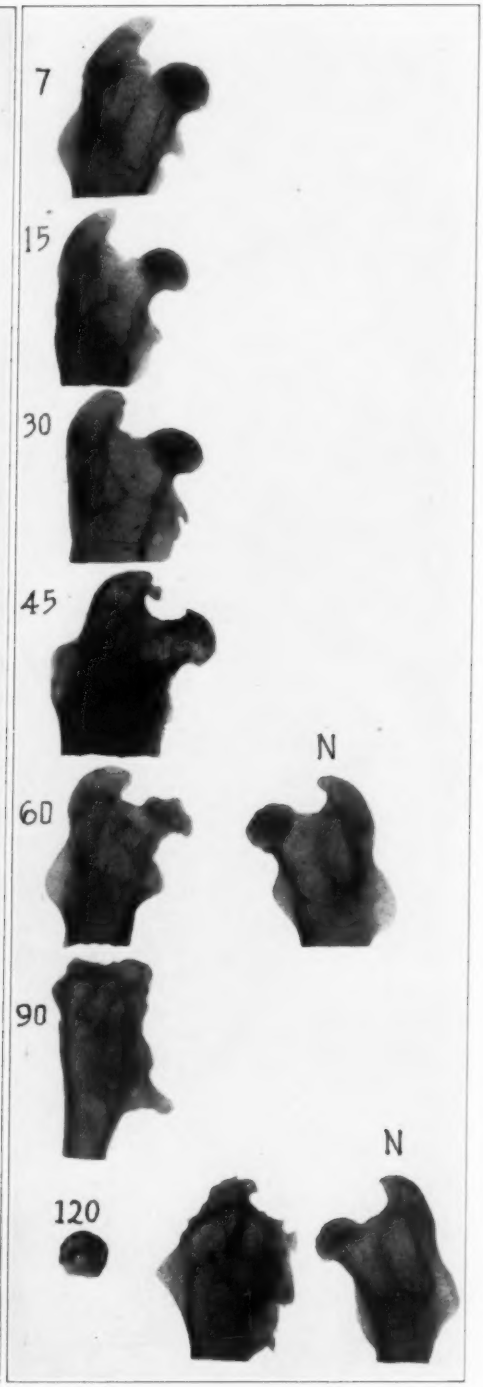

FIG. 9

Roentgenograms of Series 1-b. (Normal femora on right.)

FIG. 10

Roentgenograms of Series 2-a. (Normal femora on right.)

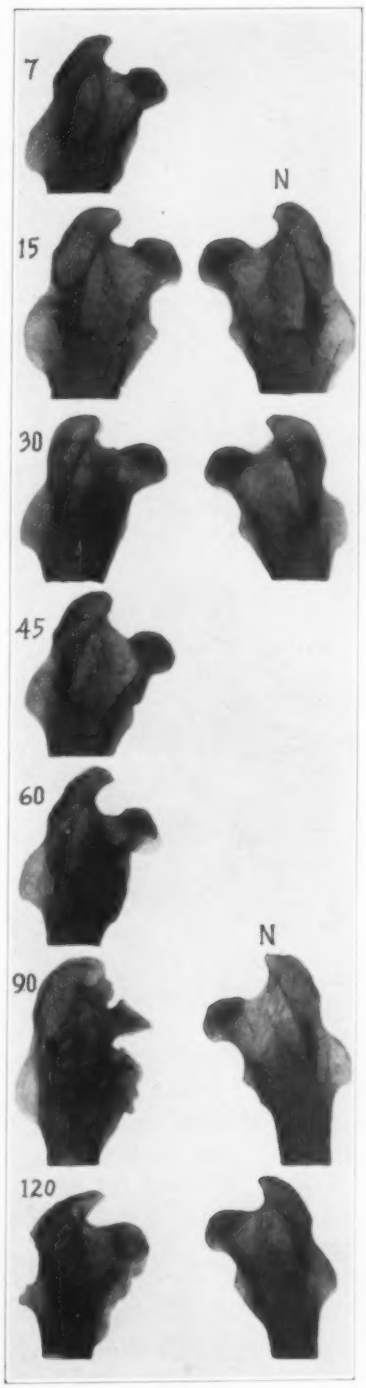

FIG. 11

Roentgenograms of Series 2-b. (Normal femora on right.)

FIG. 12

Roentgenograms of Series 3-a. (Normal femora on right.)

head. The head was quite definitely rounded but hazy in outline, with no demonstrable joint space.

At the present time, May 13, 1932, increased weight-bearing is being permitted.

It was felt that the changes in the head of the femur were due to disturbances of its circulation following its forcible dislocation from its normal situation. Three possibilities of circulatory disturbance in this condition present themselves. First, rupture of the ligamentum teres; second, the capsule may have been torn from the neck; and lastly, a combination of these may have occurred. Because the dislocation was reduced immediately by closed manipulation, one can only speculate as to what actually happened to the blood supply.

According to Kolodny [1], the blood supply of the head and neck of the femur in the new-born is from the ligamentum teres, periosteal, epiphyseal, and diaphyseal vessels; but in adult life, the ligamentum teres ceases to be a source of blood supply. However, Santos [2] has shown that vessels may be present in the ligamentum teres in adult life and be an active source of nutrition to the head. Chandler and Kreuscher [3] in a number of cases found blood vessels in the ligamentum teres, of a size indicating that they supplied an appreciable amount of blood to the head of the femur.

Graham [4], and Zemansky and Lippmann [5] have attempted to produce osteochondritic changes in femoral heads. Axhausen [6] described complete necrosis of the proximal stump ten months after fracture of the neck of the femur in a sixteen-year-old boy, with the production of arthritis deformans of the hip joint. Phemister [7], Müller [8], and Willis [9] have had

femoral heads break down after reduction of slipped epiphyses. Phemister [10] has also reported aseptic necrosis of the head and neck of the femur following arthroplasty. Broca and Massart [11] reported arthritis of the hip joint in an adult, in which an osteitis of the head developed, followed by reossification and reformation of the head. Elmslie [12] saw typical osteochondritic changes develop in a child's hip following traumatic dislocation.

Marked arthritic changes have been reported in a hip of an adult, following traumatic dislocation, by Zadek [13]. This hip, however, was not reduced until nine weeks after the accident.

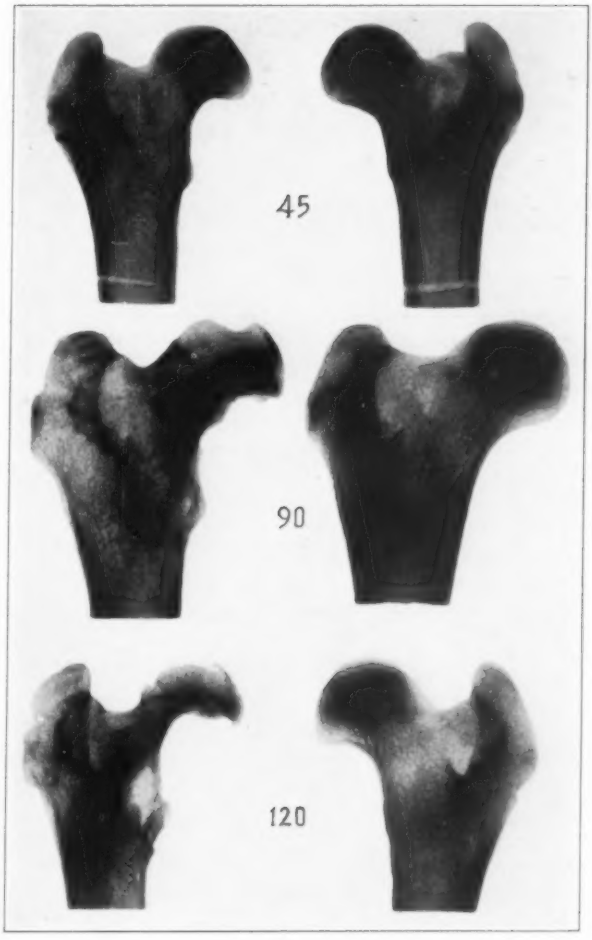

FIG. 13
Roentgenograms of Series 3-b. (Normal femora on right.)

Ferguson and Howorth [14] concluded that arthritis in adults was the usual sequela of a previously slipped epiphysis. Badgley [15] reported marked arthritic changes only in untreated cases of slipped upper femoral epiphyses.

Sonnenschein [16] reporting traumatic dislocations of hips in adults, and Murphy [17], Campbell [18], Roello [19], Maffei [20], Doelle [21], reporting cases occurring in childhood, make no mention of any marked late changes in the hips. Standard texts do not lay any great stress on the sequelae of traumatic dislocations.

Since it has been reported [2] that femoral heads may either die or remain alive following intracapsular fracture of the femoral neck, it might be surmised that in some cases of dislocation there might be enough interference with the blood supply of the head, from injury to the round ligament, to result in some degree of capital necrosis.

TABLE II

ROENTGENOGRAPHIC FINDINGS

Days	Epiphyseal lines	Contour of head	Density	Other changes	Epiphyseal lines	Contour of head	Density	Other changes
	Series 1-a. (Fig. 8)				*Series 1-b.* (Fig. 9)			
7	Head and trochanter open	No changes	Normal		Head and trochanter open	No changes	Normal	
15	Head and trochanter open		Normal		Head and trochanter open	No changes	Decreased in neck	
30	Head and trochanter open	No changes	Normal		Head nearly obliterated, trochanter open	No changes	Normal	
45	Head and trochanter open	Little flattened	Normal	None	Trochanter open, head closed	Undermining of head at superior and inferior portions at junction of head and neck	Several areas in head and neck decreased	
60	Trochanter open, head nearly closed	Somewhat flattened	Normal		Closed on operated side, open on normal	Flattened	Decreased head	Shortening of neck. Area of cavitation under fovea. Erosion of inferior portion of neck
90	Nearly closed	Irregular on superior portion	Increased in region of fovea	Cavity in inferior portion of neck		Complete destruction		Complete destruction of neck
120	Closed		Normal	Head displaced downward on neck at old epiphyseal line		Sequestrated, irregular, central area decreased density		Complete separation of head and neck
	Series 2-a. (Fig. 10)				*Series 2-b.* (Fig. 11)			
7	Closed	No changes	Normal		Closed	No changes		
15	Closed	No changes	Normal		Closed	Flattened and a little smaller		
30	Closed	No changes	Neck markedly decreased	Upward dislocation of neck on head at old epiphyseal line	Closed	No changes		
45	Closed	No changes	Some rarefaction, lower part of neck		Closed	No change		Erosion of under portion of neck

TABLE II (*Continued*)

Days	Epiphyseal lines	Contour of head	Density	Other changes	Epiphyseal lines	Contour of head	Density	Other changes
	Series 2-a. (Fig. 10) (*Continued*)				*Series 2-b.* (Fig. 11) (*Continued*)			
60	Closed	Complete destruction (infected)		Complete absorption of head and neck	Closed	Little smaller and flattened	Neck decreased	Erosion of head and neck
90	Closed	Smaller	Some rarefaction of the neck	Erosion of under portion of the neck				Complete destruction of head, most of neck remaining
120	Closed	Smaller and flattened	Rarefaction of both head and neck	Erosion of under portion of neck	Closed	Smaller	Head decreased	Erosion of under portion of neck
	Series 3-a. (Fig. 12)				*Series 3-b.* (Fig. 13)			
45	Closed	Somewhat smaller	Neck shows generalized rarefaction	Neck narrowed, slight destruction of under portion of neck. Fracture line through the neck, produced accidentally at necropsy	Closed	No changes	Normal	
90	Closed		Inferior portion of the head markedly decreased with spotty areas of reduced density in the weight-bearing portion above, loss of shadow of articular cortex in a part of its extent	Marked erosion of under part of neck	Closed	No changes	Superior portion of head decreased	Marked erosion of under part of neck at its junction with the head, and extending downward with some sclerosis of the adjacent bone
120	Closed	No changes			Closed	No changes	Neck and trochanter generally decreased	Destruction of almost the entire mesial and inferior half of the neck

TABLE III

MICROSCOPIC EXAMINATIONS

	Series 1-a.	*Series 1-b.*
Days	Division of Ligamentum Teres in Young Rabbits.	Division of Ligamentum Teres and Circumcision of Neck in Young Rabbits.
7	Small area of fibrous marrow in center of head, with some absorption of adjacent bone trabeculae. No other changes.	No changes in head or neck.
15	No changes in head or neck.	Bone atrophy in the head, rather fatty marrow. No other changes.
30	Cartilage is thinned below the fovea. Many bone-marrow giant cells.	Some bone atrophy of the trabeculae of the head.
45	Slight flattening of the head. No other changes.	Small vessels in the stump of ligamentum teres. Undermining of each end of the cartilage by fibrous marrow which fills up of the cancellous spaces of the head. Some dead bone in cartilage at the superior portion. Large cavity in neck. Many of the trabeculae of head have new bone deposited on original old trabeculae, in which the bone cells are absent. Nearly complete transformation of the head (Fig. 14).
60	Cartilage alive but irregular in thickness. Marked bone sclerosis below the fovea.	Loss of articular cartilage over superior weight-bearing portion, with fibrous-tissue invasion of the cortical bone. Marked fibrous-tissue invasion beneath the fovea. Cancellous spaces of the superior portion of the head contain active hemopoietic marrow. Rest of the cancellous spaces contain fibrous marrow. Below the fovea there are several trabeculae which show bone absorption on one side, with new bone production on the other side (Figs. 15, 16). The trabeculae in the inferior portion show dead bone surrounded by new bone. There are numerous small pieces of dead bone scattered through the fibrous marrow. Creeping substitution most marked in the central and inferior portion of the head. Nearly complete transformation of the head.
90	Loss of articular cartilage over all the head except at each end. Marked bone sclerosis in the head. Most of the central cancellous spaces contain fibrous marrow, with fatty marrow in the remaining spaces of the head.	Complete destruction of the head and neck due to infection.
120	No changes in the head or neck. Few small vessels in the stump of the ligamentum teres.	Inferior portion of the neck stub is covered with fibrocartilage. Bone of the sequestrated head is dead, covered with dead calcified cartilage. Cancellous spaces contain cellular débris with many polymorphonuclear cells.

	Series 2-a.	*Series 2-b.*
Days	Division of Ligamentum Teres in Old Rabbits.	Division of Ligamentum Teres and Circumcision of Neck in Old Rabbits.
7	Small area of fibrous marrow in inferior portion of head, with adjacent bone absorption. No other changes.	Small area of fibrous marrow in center of neck, adjacent to head, with some bone absorption. No other changes.
15	Fibrous marrow extends across entire neck in region of old epiphyseal line, with adjacent bone absorption. Marrow of rest of head is fatty.	Cartilage over superior portion is thinned. Fibrous marrow in center and inferior portion of head and all of neck, with some adjacent bone absorption.

TABLE III (*Continued*)

	Series 2-a. (*Continued*)	*Series 2-b.* (*Continued*)
Days	Division of Ligamentum Teres in Old Rabbits.	Division of Ligamentum Teres and Circumcision of Neck in Old Rabbits.
30	Cartilage irregular, with overlying adhesions, and dead. Bone trabeculae dead, marrow dead. Large cavity in neck, with a large area of granulation tissue back of this, containing live bone trabeculae and many polymorphonuclear cells. Infected.	Cartilage thin, irregular, head flattened. Marrow is fatty.
45	No changes.	No changes.
60	Infected. Head and neck destroyed.	Defect in cartilage over superior portion of head, with fibrous-tissue invasion. Head is smaller. Active hemopoietic marrow in cancellous spaces. Several areas of new bone production in the head. Many of the trabeculae have dead central portions surrounded by new living bone. All are very much thickened. Apparently head has been transformed.
90	Sclerosis of bone trabeculae. No other changes.	Complete collapse of the head (Fig. 17). The central portion has a thick covering of cartilage with underlying bone growth. There is a section of dead cartilage below this, with another section of articular cartilage remaining at the inferior portion which is collapsed. Fibrous-marrow invasion throughout most of the head. New bone production surrounding old bone trabeculae. Nearly complete transformation of the remaining bone of head. Marked bone sclerosis in the neck.
120	Cartilage worn away at each end. Area of fibrous marrow beneath the fovea, with adjacent bone absorption and new bone production.	Cartilage undermined and collapsed at each end, with some fibrous marrow in the lower portion of the head and neck.

	Series 3-a.	*Series 3-b.*
Days	Division of Ligamentum Teres in Adult Dogs.	Division of Ligamentum Teres and Circumcision of the Neck in Adult Dogs.
45	Cartilage is thin, covered with adhesions in region of the fovea. Cartilage is dead and undermined by fibrous marrow in inferior portion, with underlying dead bone trabeculae showing some absorption.	Good-sized area of fibrous marrow in the inferior portion of the neck, with adjacent bone absorption. Osteophyte formation at the superior portion of the neck, behind the cartilage, evidence of arthritis (Fig. 18).
90	Cartilage is narrowed over most of weight-bearing portion of head. At the fovea, the cartilage is dead. Some bone atrophy in head. Evidence of lipping, osteophyte production behind the articular cartilage, on the neck.	Loss of cartilage over superior portion of head, replaced by thin fibrous tissue adherent to surrounding soft parts. Below the fovea, it is reduced in thickness; cells are necrotic and broken down. Still lower, it is undermined by fibrous marrow at margin, but is alive. The neck shows surface erosion inferiorly, with bone sclerosis above this region. Bone atrophy in the upper part of the head and neck (Fig. 19).
120	No changes in head and neck.	Superior portion of cartilage is thinned. It is undermined at lower portion by fibrous marrow and collapsed. Bone atrophy of the superior portion of the head. More marked erosion of the under surface of the neck, with overlying bone sclerosis (Figs. 20 and 21).

FIG. 14

Series 1-b, 45 days (× 20). Large defect in the central portion of head and neck. Sclerosis of remaining trabeculae; most of the trabeculae around the periphery have been transformed.

Accordingly, an attempt was made to interfere with the blood supply of the head of the femur in animals by division of the ligamentum teres or ligamentum teres and periosteum of the neck. Six series of ex-

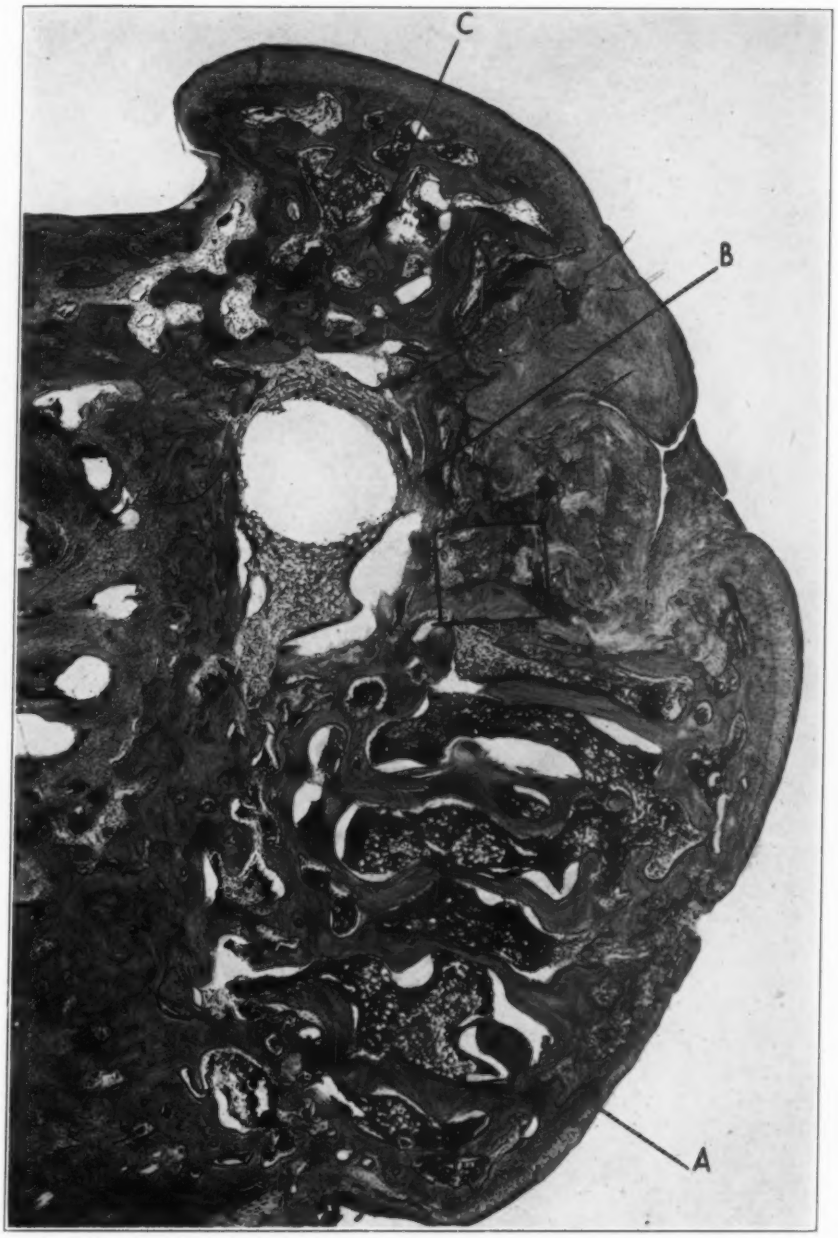

FIG. 15

Series 1-b, 60 days (× 25). Square reproduced in higher power in Fig. 16. *A*. Loss of cartilage over superior weight-bearing portion of head, with underlying cancellous spaces containing hemopoietic marrow. *B*. Active new bone growth. *C*. Old trabeculae surrounded by new bone and with adjacent cancellous spaces containing fibrous marrow.

FIG. 16

Photomicrograph (× 260) from Series 1-b, 60 days, taken from region below the fovea, showing: *A*, fibrous marrow; *B*, new bone growth, *C*, bone absorption, with a portion of an old, dead trabeculum surrounded by living bone.

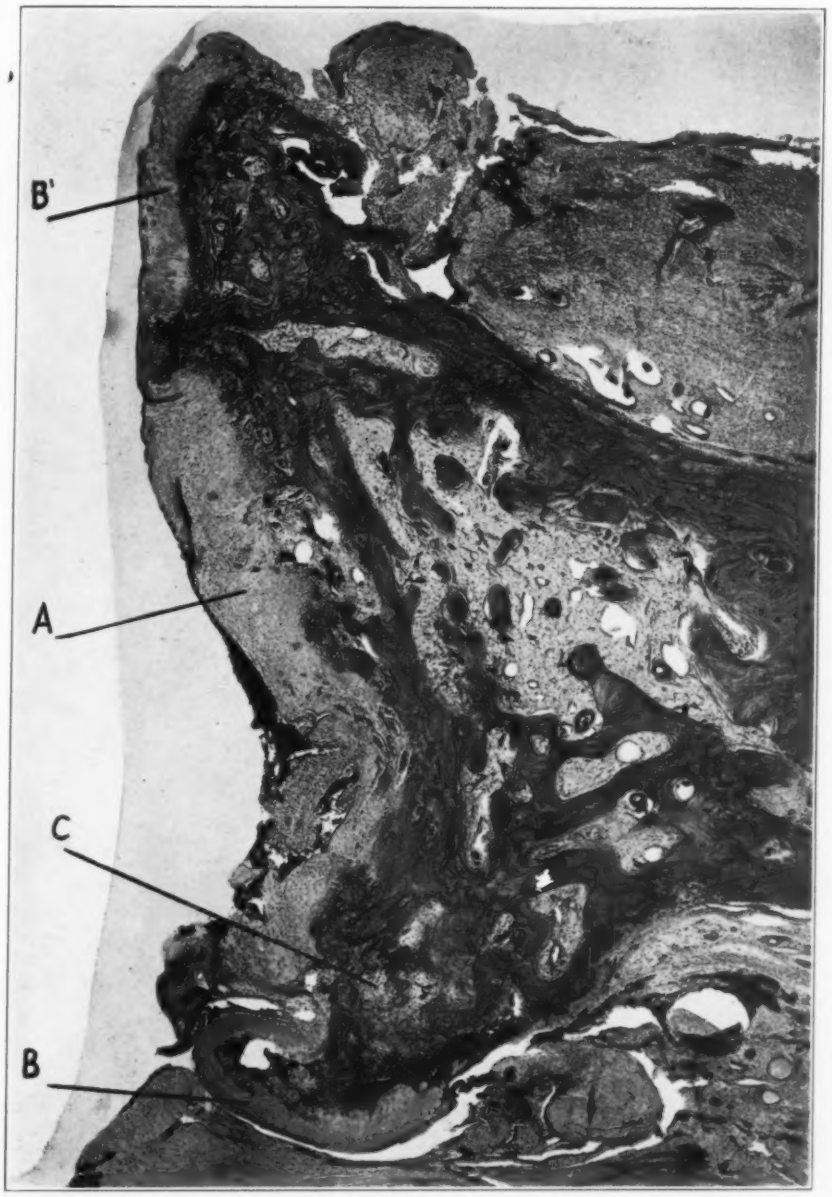

FIG. 17

Series 2-b, 90 days (× 25). Collapse of head. *A*. Fibrocartilage over central, collapsed portion. *B, B'*. Remnants of old articular cartilage. *C*. Fibrous marrow with adjacent active new bone growth. Generalized sclerosis of trabeculae.

periments were done. Rabbits about six weeks old, with open epiphyses, older rabbits with closed epiphyses and dogs with closed epiphyses, estimated to be three or four years old, were operated on and the results noted after varying intervals of time.

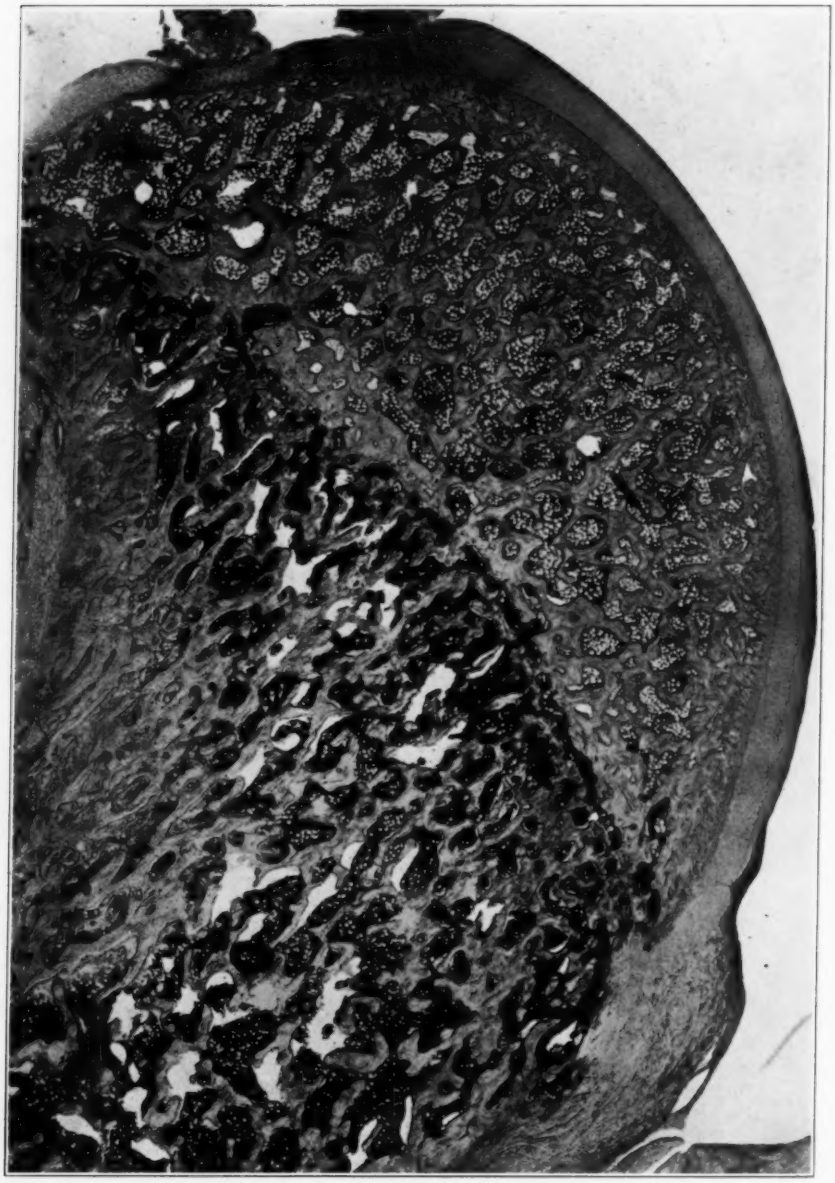

FIG. 18

Series 3-b, 45 days. Photomicrograph of head and neck (× 10), showing surface absorption of inferior portion of neck.

The following experiments were performed:

Series 1-a. The ligamentum teres in one hip of each young rabbit was divided. Seven animals were used and were killed at 7, 15, 30, 45, 60, 90, and 120 day intervals. The femora were then x-rayed and sectioned.

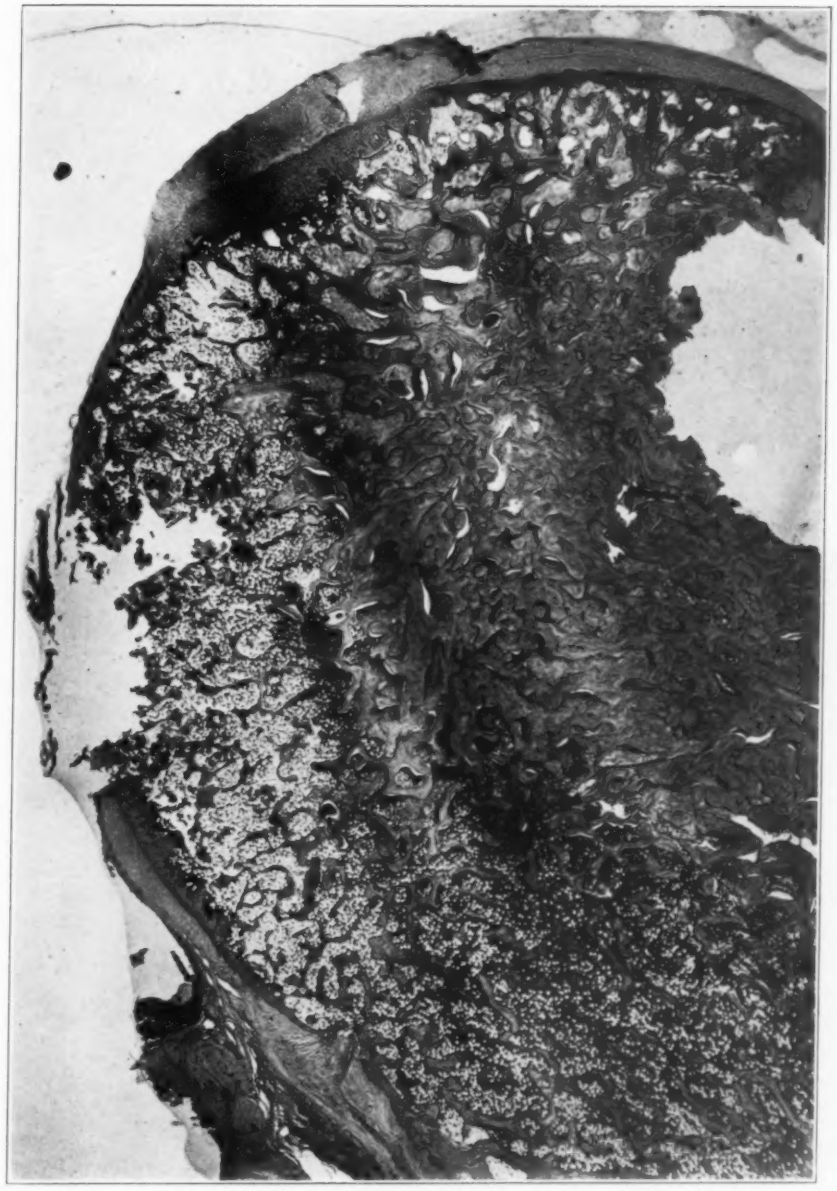

FIG. 19

Series 3-b, 90 days (× 7). Marked erosion of inferior portion of neck, sclerosis of trabeculae of neck and head, inferiorly, and atrophy of superior portion. Remnants of adherent capsule with loss of cartilage at the top.

Series 1-b. The ligamentum teres in one hip of each young rabbit was divided and the periosteum of the neck circumcised by carrying a curved knife through it just below the head. The animals were killed at the same intervals as above, femora x-rayed and sectioned.

FIG. 20

Series 3-b, 120 days (× 10). Square reproduced in higher power in Fig. 21. Generalized atrophy of trabeculae of the head, with sclerosis of inferior portion of neck and surface absorption. No bone necrosis.

Series 2-a. Same procedure as in Series 1-a, using adult rabbits.

Series 2-b. Same procedure as in Series 1-b, using adult rabbits.

Series 3-a. The ligamentum teres was divided in one hip of each adult dog, and the animals killed at 45, 90, and 120 day intervals. The femora were then x-rayed and sectioned.

FIG. 21

Photomicrograph (× 120) showing sclerosis and surface absorption, with normal trabeculae and cancellous spaces. Section from inferior part of head and neck of Series 3-b, 120 days.

Series 3-b. The ligamentum teres was divided in one hip of each adult dog, and the periosteum of the neck circumcised. Animals were killed at 45, 90, and 120 day intervals, femora x-rayed and sectioned.

The necropsy, roentgenographic, and microscopic findings are shown in Tables I, II, and III, with accompanying illustrations.

A résumé of the results of the experiments reveals four examples of aseptic necrosis of the head of the femur, followed by nearly complete transformation. All of these occurred after the more extensive method of devascularization,—namely, division of the ligamentum teres and circumcision of the periosteum of the neck. No marked changes occurred in the animals in which the ligamentum teres alone was cut.

No regular sequence of events in the progression of aseptic necrosis, followed by transformation of the head, was demonstrated. In several of the heads which were examined early in each series, small areas of fibrous marrow were found, but there are none that show the course of events between these and the heads which represent an advanced stage of transformation.

The absorptive changes which took place in the neck of the femur in each animal of Series 3-b are not well understood at this time. It is possible that there are end arteries in the neck of the femur, on the inferior aspect, which were injured at the time of operation, but additional work must be done before the changes can be interpreted. The heads of these femora present little evidence of aseptic necrosis, most of the changes being on a basis of arthritis and bone atrophy.

SUMMARY

1. The case reported is of interest because, despite the relative frequency of traumatic dislocation of the hip with accompanying tear of the round ligament, no report was found in the literature of a similar case of aseptic necrosis and breaking down of a part of the head of the femur as a sequel. The chronic arthritis of the hip appeared to be secondary to the necrosis. The picture is somewhat similar to that sometimes seen in intracapsular fracture of the neck of the femur, with necrosis of the head, in which bony union occurs but the head subsequently breaks down as a result of weight-bearing before bony transformation has taken place. When it becomes evident from roentgenograms that aseptic necrosis in the femoral head from any cause has occurred, weight-bearing should be avoided during the period of repair. A study of the late results of hip dislocation might reveal similar cases.

2. Attempts were made to reproduce the picture in dogs and rabbits by cutting the ligamentum teres and, in some cases, also the vessels in the periosteum of the femoral neck. They were only partially successful. A part of the bone died in some experiments, as shown in Table III, and was transformed; but in no instance was collapse of the head and necrosis of its articular cartilage observed. The divided ligamentum teres showed a distinct tendency to unite in the experimental animals. It appears that the vascular supply of the head of the femur by way of vessels within the femoral neck of these animals was usually sufficient to preserve the vitality of the head.

3. There was no regularity in the process of transformation of the femoral heads following operative circulatory interference. Apparently, the variability of the blood supply to the head of the femur is such that, by interrupting identical portions of it in a series of experimental animals, identical and progressive stages of aseptic necrosis, followed by transformation of the femoral heads, could not be demonstrated. There is a certain individual reaction of each head in a series of similar operative procedures.

4. The ligamentum teres showed a distinct tendency to unite after operative division.

5. No head in the animals with open epiphyseal lines showed changes similar to Legg-Calvé-Perthés' disease.

BIBLIOGRAPHY

1. Kolodny, A.: The Architecture and the Blood Supply of the Head and Neck of the Femur and Their Importance in the Pathology of Fractures of the Neck. J. Bone and Joint Surg., VII, 575, July 1925.
2. Santos, J. V.: Changes in the Head of the Femur after Complete Intracapsular Fractures of the Neck; Their Bearing on Nonunion and Treatment. Arch. Surg., XXI, 470, 1930.
3. Chandler, S. B., and Kreuscher, P. H.: A Study of the Blood Supply of the Ligamentum Teres and Its Relation to the Circulation of the Head of the Femur. J. Bone and Joint Surg., XVI, 834, Oct. 1932.
4. Graham, R. V.: Experimental Considerations in Perthes's Disease. Med. J. Australia, I, 207, 1930.
5. Zemansky, A. P., Jr., and Lippmann, R. K.: The Importance of the Vessels in the Round Ligament to the Head of the Femur During the Period of Growth and Their Possible Relationship to Perthes' Disease. Surg. Gynec. Obstet., XLVIII, 461, 1929.
6. Axhausen, G.: Die Nekrose des Proximalen Bruchstücks beim Schenkelhalsbruch und ihre Bedeutung für das Hüftgelenk. Arch. f. Klin. Chir., CXX, 325, 1922. (Abstracted in J. Am. Med. Assn., LXXIX, 1370, 1922.)
7. Phemister, D. B.: Personal Communication.
8. Müller, W.: Experimentelle Untersuchungen über Nekrosen und Umbauprozesse am Schenkelkopf nach Traumatischen Epiphysenl sungen und Luxationen und ihre Klinische Bedeutung. Beitr. z. Klin. Chir., CXXXII, 490, 1924. (Abstracted in J. Am. Med. Assn., LXXXIII, 1958, 1924.)
9. Willis, T. A.: The Slipping Femoral Epiphysis. J. Bone and Joint Surg., XI, 779, Oct. 1929.
10. Phemister, D. B.: Repair of Bone in the Presence of Aseptic Necrosis Resulting from Fractures, Transplantations, and Vascular Obstruction. J. Bone and Joint Surg., XII, 769, Oct. 1930.
11. Broca, A., et Massart, R.: Arthrites de la Hanche avec Aplatissement et Fragmentation de la Tête Fémorale. Rev. de Chir., LXI, 169, 1923. (Abstracted in J. Am. Med. Assn., LXXXI, 511, 1923.)
12. Elmslie, R. C.: Pseudocoxalgia Following Traumatic Dislocation of the Hip in a Boy Aged Four Years. J. Orthop. Surg., I, 109, Feb. 1919.
13. Zadek, I.: Complicated Traumatic Dislocation of the Hip; Report of Three Cases. J. Bone and Joint Surg., XII, 419, April 1930.
14. Ferguson, A. B., and Howorth, M. B.: Slipping of the Upper Femoral Epiphysis; A Study of Seventy Cases. J. Am. Med. Assn., XCVII, 1867, 1931.

15. Badgley, C. E.: Displacement of Upper Femoral Epiphysis; Summary of Twenty-Seven Studied Cases. J. Am. Med. Assn., XCII, 355, 1929.
16. Sonnenschein, H. D.: Traumatic Dislocation of the Hip. J. Bone and Joint Surg., XI, 96, Jan. 1929.
17. Murphy, D. P.: Traumatic Luxation of the Hip in Childhood: Report of Case. J. Am. Med. Assn., LXXX, 549, 1923.
18. Campbell, W. C.: Perineal Dislocation of the Hip with Avulsion of the Greater Tuberosity. J. Am. Med. Assn., LXXVIII, 1115, 1922.
19. Roello, G.: Sulla Lussazione Traumatica dell'Anca nell'Infanzia. Chir. d. Org. di Movimento, VI, 119, 1922. (Abstracted in J. Am. Med. Assn., LXXIX, 414, 1922.)
20. Maffei, F.: Contributo allo Studio della Lussazione Traumatica dell'Anca nell' Infanzia. Chir. d. Org. di Movimento, VI, 604, 1922. (Abstracted in J. Am. Med. Assn., LXXIX, 1885, 1922.)
21. Doelle, O.: Beitrag zur Traumatischen Hüftgelenksluxation bei Kindern. Arch. f. Klin. Chir., CXVIII, 703, 1921. (Abstracted in J. Am. Med. Assn., LXXVIII, 852, 1922.)
22. Cotton, F. J.: Dislocations and Joint-Fractures, Ed. 2. Philadelphia, W. B. Saunders Co., 1924.
23. Campbell, W. C.: A Textbook of Orthopaedic Surgery. Philadelphia, W. B. Saunders Co., 1930.
24. Whitman, Royal: A Treatise on Orthopaedic Surgery. Ed. 8. Philadelphia, Lea & Febiger, 1927.
25. Jones, Sir Robert, and Lovett, R. W.: Orthopaedic Surgery. Ed. 2. New York, William Wood and Co., 1929.

THE KRUKENBERG STUMP *

BY RALPH COLP, M.D., F.A.C.S., AND NICHOLAS S. RANSOHOFF, M.D., NEW YORK, N. Y.

There are very few industrial injuries, or congenital deformities, more depressing to the surgeon, and more disabling to the patient, than the loss of a hand. The unfortunate individual faces a dismal economic future unless something can be done to convert a useless extremity into one which can assume some independent motion.

The application of an artificial hand to a healed forearm stump, while creating a better cosmetic appearance, does little to aid the one who wears the prosthesis, although the palmar slot arrangement in the artificial hand permits the insertion of pencils, knives, forks and other appliances. If the forearm, however, could be converted into a grasping extremity, sensitive to tactile sensations, heat and cold, a result would be obtained far superior to any insensitive immobile artificial hand.

Krukenberg, in 1917, described an ingenious operation to serve this purpose, but, unfortunately, the procedure seems to be but little known. The operation is simple. It consists of dividing the forearm, separating the radius from the ulna, giving each bone an individual muscular supply and skin covering. The end result is not unlike the claw of a lobster in appearance. The ulna remains immobile while the radius revolves and retains its ability to pronate and supinate. This operation is much simpler than the various kineplastic procedures which have been advocated, and, when completed, a complicated prosthesis is not necessary. It has the additional advantage over the other kineplastic procedures that it may be done at the time of the traumatic amputation in selected cases. If desired, a simple artificial hand may subsequently be fitted, which not only answers a cosmetic purpose, but also proves useful because of a mobility of the hand, transmitted through the mobile radial stump. A working prosthesis has also been manufactured which will enable the wearer to actually perform very heavy manual labor. These appliances hide the stump and answer in part the argument that the mobile claw is extremely unsightly. There is no doubt that this statement is true but after all a forearm which is strong, sensitive, and useful certainly outweighs the aesthetic side of this industrial problem.

Krukenberg recommended that the stump be at least twelve centimeters long, but others—notably Biesalski—have been willing to do the operation with a shorter stump (eight centimeters). The technique of the operation is simple, and it is easily performed under a tourniquet. An excellent detailed description of the procedure is given in Bier, Braun, and Kümmell.[1] A brief résumé is herewith appended:

* From the Surgical Service of the Beekman Street Hospital, New York, N. Y., and the Orthopaedic Service of the Monmouth Memorial Hospital, Long Branch, New Jersey.

1. A U-shaped incision is made from the volar to the dorsal aspect of the forearm, slightly to the ulnar side, and over the attachment of the interosseus membrane to the ulna.

2. The dorsal incision is deepened to the extensor muscles. The extensor communis digitorum is identified, and the tendons to the second and third finger are sutured together. The tendons to the fourth and fifth fingers are similarly sutured. The extensor carpi ulnaris is left on the ulnar side. The brachioradialis and both extensor carpi radialis muscles are attached to the radius. The abductor pollicis longus, the extensor pollicis longus, and brevis are excised.

3. The volar incision is now deepened to the flexor muscles. The flexor carpi ulnaris and radialis are left on their respective sides. The divisions of flexor sublimis digitorum are treated similar to the extensor communis digitorum. The flexor profundus digitorum and the flexor longus pollicis are extirpated.

4. The median and ulnar nerves are identified and adequately resected and the stumps injected with alcohol.

5. The interosseus membrane is then slit *throughout* its length and removed, so that the radius and ulna are then separated for about twelve centimeters of their extent.

6. The flexor and extensor tendons are then sutured together over the radius and ulna respectively.

7. The radial stump as a rule may be covered with the overlying skin which is present.

8. It is very seldom, however, that there is sufficient integument to cover the ulna stump. It is usually advisable to do a pedicle skin graft to this stump from the side of the abdomen. This is best performed by making a skin flap and suturing it to the skin left on the ulna. The stump is immobilized to the abdominal wall for ten to twelve days. The skin flap is then freed from the abdomen and the closure completed.

FIG. 1
Case 1. Claw closed.

FIG. 2
Case 1. Claw opened.

FIG. 3

Case 1. Showing how girl holds her fork. She is able to feed herself easily with this. She has excellent control of the fork.

FIG. 4

Case 1. Showing her ability to grasp small objects, such as a pencil. She does not write with this, inasmuch as it is her left arm.

9. After the wounds have healed, active and passive exercises are begun, and pronation and supination are encouraged. After these motions are mastered, a pseudo-abduction and pseudo-adduction are apparent.

A very satisfactory mobile stump may be constructed by this method, and the histories of two patients which are herewith reported bear witness to the efficiency of the Krukenberg procedure.

CASE 1. J. B., aged fourteen, was admitted to the Monmouth Memorial Hospital at Long Branch, New Jersey, with a diagnosis of intra-uterine amputation of the left forearm.

The girl came to the clinic to inquire whether or not something might be done, or some prosthesis made, so that she might have some use of her left arm.

Her family history showed that she had a nephew with a congenital talipes equinovarus; otherwise the family history was negative.

She was admitted to the hospital December 17, 1929, at which time her physical examination was negative, except that it showed a stump of the left forearm, eight centimeters in length.

We realized that this would give a claw

FIG. 5

Case 2. Showing forearm before Krukenberg amputation.

FIG. 6

Case 2. Showing Krukenberg claw in pronation.

FIG. 7

Case 2. Showing Krukenberg claw in supination.

FIG. 8

Case 2. Showing grasping power of claw.

with very short fingers. Under gas-oxygen-ether anaesthesia, a typical Krukenberg operation was done December 22, 1929. The one variation from the technique was that both the radial and ulnar components of the stump were enclosed in the original skin by a primary suture. This was a mistake, as both the suture lines sloughed out. Therefore, under narcosis, a pedicle skin graft was done March 2, 1930. The pedicle was removed from its base March 19, 1930, with a primary union of the graft. A pinch graft of the pedicle bed was done at the same time.

At the present time, she has a short but useful Krukenberg stump; there are pronation and supination which give the effect of adduction and abduction. She is able to grasp small objects and hold them firmly; she uses her left forearm to hold a fork while eating; and, in general, is very happy with the result.

CASE 2. R. T., a school boy, twelve years of age, was admitted to the Surgical Service of the Beekman Street Hospital October 27, 1930, and discharged January 21, 1931.

On the day of admission, the patient held an ignited torpedo in his hand, which subsequently exploded. He was immediately brought to the hospital.

Physical examination disclosed a maceration and avulsion of the entire right hand up to and including the wrist joint, so that no bones were spared in the destruction. There were also powder wounds which extended through the skin into the soft parts, over the lateral aspect of the arm on the same side, to the mid-brachial region.

Under ether anaesthesia, an amputation of the right hand and wrist was performed through the carporadial articulation. The periosteum of the radius and ulna was not disturbed. The skin was trimmed for a considerable distance and the parts remaining looked very clean. The whole area was thoroughly irrigated with saline and a few

chromic sutures approximated the muscle and fascial elements over the ends of the bone, the skin being closed with a few submarine silk sutures. At the same time a débridement was also done on the powder wounds of the arm. Two pieces of iodoform gauze were inserted into the defects of the arm and the wound dressed dry.

There was considerable sloughing following the procedure, but under dakinization the stump was clean enough for a thiersch graft on November 21, 1930. This was subsequently supplemented by pinch grafts. The forearm was ready for a Krukenberg plastic operation on January 21, 1931.

On January 28, 1931, the wound was dressed. The skin flap around the stump of the radius had sloughed, while the pedicle flap to the ulna was viable.

On February 11, under general anaesthesia, the pedicle to the graft was divided and sutured about the ulna, although part of it remained uncovered.

On February 25, under anaesthesia, pinch grafts were taken from the right anterior femoral region and placed on the granulating area over the radius and parts of the ulna, and paresine dressing applied.

On March 4, 1931, the boy had amazing grasping power of the stump. The ulna was practically healed and about thirty per cent. of the pinch grafts of the radius had taken.

The patient was discharged on March 11, 1931, at which time the stumps had practically healed. There was complete extension at the elbow and the patient had good grasping power of the stumps. Since that time patient has been seen on many occasions. He has complete flexion and extension of the elbow; pronation and supination of the radius about the ulna is complete, although abduction and adduction of the radial stump are practically negligible.

1. Bier, A., Braun, H., und Kümmell, H.: Chirurgische Operationslehre. Leipzig, J. A. Barth, V, 225, 1912.

ABSENCE OF THE CERVICAL SPINE *

KLIPPEL-FEIL SYNDROME

BY LEWIS GREENBERG, M.D., NEW YORK, N. Y.

In 1912, Klippel and Feil [5] first described in detail the clinical, roentgenological, and anatomical features of the relatively rare and obscure syndrome since known by their names. Their patient was an adult male, admitted to the hospital for an unrelated medical complaint which eventually resulted in death. The appearance of the patient, however, was so unusual and arresting that he was closely studied during life and minutely examined postmortem. Since the signs and symptoms exhibited by this patient were characteristic of all cases of the Klippel-Feil syndrome reported by other observers, they will be described here.

The most noticeable feature is an apparent absence of the neck; the head seems to rest directly on the trunk. This has led the French to designate these patients as "*hommes sans cou*," while the Germans refer to the condition as "*Kurzhals*". Another feature is the unusually low level of the posterior hair line (of the scalp); this actually reaches to the upper portion of the posterior thoracic wall. A third sign is considerable limitation of the movements of the head in all directions. With these very frequently there are present varying degrees of limitation of movements of the mouth (preventing satisfactory roentgenography of the upper cervical vertebrae), scoliosis or kyphoscoliosis of the upper dorsal region, elevation of the scapula as in Sprengel's deformity (often the first anomaly noticed by the patient or his family), and other congenital deformities or malformations. Some patients exhibit mental retardation of varying degree, although others are of normal intelligence. A few have shown functional impairment of the upper extremities, suggestive of a common neurogenous origin. Roentgenologically there is a bony block of all or most cervical vertebrae, with malformation and irregular segmentation of the remaining non-fused vertebrae,—the net result being considerable deformity of the cervical spine and numerical reduction of its component elements, a bone defect in the posterior portion of this cervical block (spina bifida), and a thorax extending upward practically to the base of the skull.

It is this roentgenographic appearance which has caused many writers to refer to the syndrome as "absence of the cervical spine". This term is quite obviously a misnomer for, while these patients show the most varied deformity and reduction in the number of cervical vertebrae, there is never a true total absence of the cervical spine.

As to etiology, the condition is manifestly a developmental anomaly, but the precise chronological and morphological point of departure

* From the Orthopaedic Service, Hackensack Hospital, Hackensack, New Jersey.

from normal growth is still one of the mysteries of embryology.

Since the first description of the syndrome originated from France, it is but natural that the most detailed study of the condition and the greatest number of case reports emanate from French sources. Petresco-Poissonnier[10] has gathered all the known data about the syndrome into a thesis, in which she also reports two clinical cases. As summarized by this author, the outstanding features of the Klippel-Feil syndrome are: (1) important or constant clinical signs,—absence of neck (short, wide, "bull" neck), low hair line, and limitations of movements of the head; (2) secondary or occasional signs,—limitation of movements of the mouth, scoliosis or kyphoscoliosis, elevation of the scapula, lowering of the nipples toward the symphysis pubis; (3) roentgenographic signs,—bony fusion of all or most cervical vertebrae, posterosuperior triangular defect in this bony mass (cervical spina bifida), thorax reaching to base of skull (cervical thorax), and basal kyphosis,—*i.e.*, exaggerated downward direction of the posterior cranial fossa.

FIG. 1

Monestier[7] devotes himself to a consideration of the syndrome exclusively from the roentgenographic point of view, stressing the fact that an exact diagnosis must rest ultimately on the x-ray appearance of the cervical spine. In his experience the most constant findings were: bony block of all or almost all cervical vertebrae, cervical spina bifida, and cervical thorax. This author also quotes approvingly Feil's technical instructions for the successful roentgenographing of these subjects: forty-five centimeters' distance for localization of individual vertebrae or seventy centimeters for total roentgenography, one to four seconds' exposure, current of thirty to forty milliamperes, spark gap of seven to ten centimeters; no intensifying screens to be used; duration of exposure to be reduced for children. He calls attention to the occasional difficulty encountered in subjects with limitation of movements of the mouth when attempting to roentgenograph the upper cervical vertebrae.

Crouzon and Liège[3] describe the pathological findings in one of the rare cases of Klippel-Feil syndrome where postmortem study was possible. They found a reduction in the number of cervical vertebrae and great malformation and irregular fusion of the segments present, especially of the atlas and axis; the remainder of the spine was practically normal.

Ingelrans and Piquet[4] report two cases where, in addition to the anomalies and malformations of the cervical spine, there were present asymmetry of the face, deficient dentition, maldevelopment of the pinnae, and deformity of one forearm and hand. However, in one of these cases the authors thought they could find a syphilitic basis.

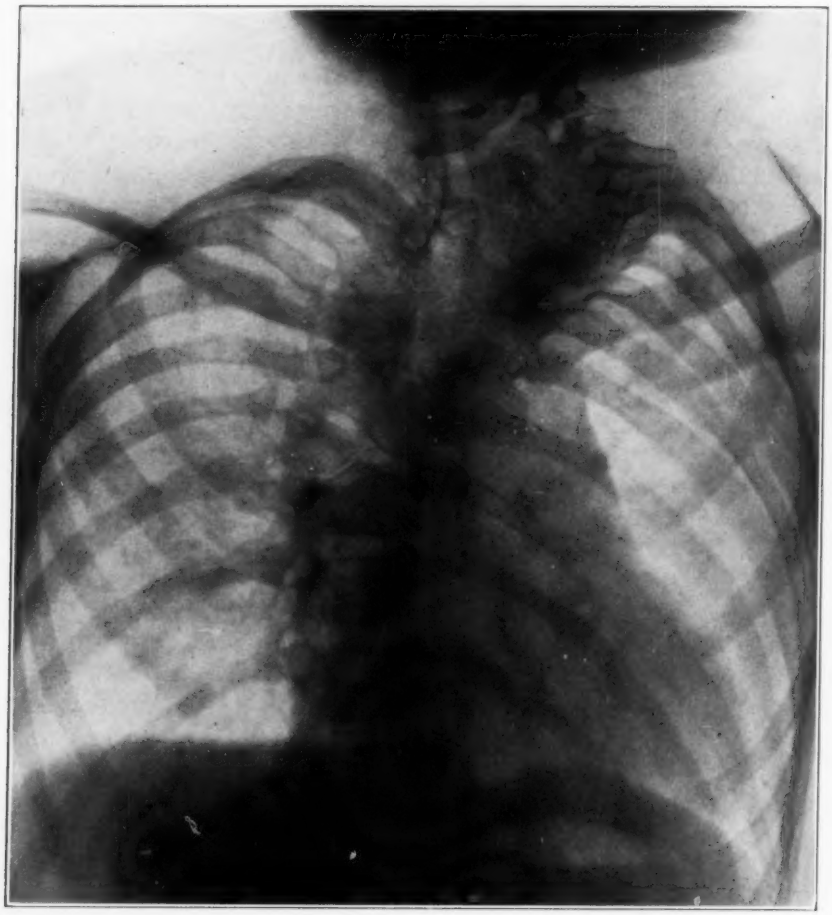

FIG. 2

Several other clinical cases are reported by French writers. Next in the number of case reports are those from Italy; isolated cases are on record from England, Holland, Germany, Russia, and the Scandinavian countries. From the United States there have been case reports by Meisenbach [6], Noble and Frawley [8, 9], and Bauman [1]. Sever [11], in reporting a series of cases of anatomical defects of ribs and the spine as a whole, includes one case which would now be classified as Klippel-Feil syndrome. The total number of cases reported seems to be well below fifty.

The importance of recognizing the condition lies not in any hope of remedying the deformity—the therapeutic expectations are absolutely nil—but in its differentiation from two other conditions which present a somewhat similar appearance and which are amenable to surgical treatment,—namely, congenital torticollis and Pott's disease of the cervical spine. The affections have been confused, and there are instances where operation was undertaken under the erroneous impression that one of the

FIG. 3

latter conditions was being dealt with, with embarrassing and disappointing results. A frank, detailed report of such a misadventure is given by Böhm[2]. A boy, aged six and a half years, exhibited what looked clinically like the usual type of congenital torticollis (rotation of head to the right, inclination on the left shoulder, very short, thick, taut sternocleidomastoid). The patient was operated on, the usual myotomy being performed, followed by immobilization in the hypercorrected position. When the plaster was removed the deformity recurred at once. A further period of immobilization was followed by a similar result. Roentgenography revealed characteristic Klippel-Feil malformations.

It would also appear desirable to investigate the cervical spine in all patients presenting Sprengel's deformity, since this is relatively frequently one of the elements of the Klippel-Feil syndrome.

CASE REPORT

R. R., a five-year-old white girl (Fig. 1), was brought for examination because of a lump situated above the left shoulder which was said to interfere with movements of the head. This lump had existed since infancy and had increased in size proportionately as the child grew. It was not painful. The girl had been born *per vias naturales* without difficulty, and had developed normally, physically, and mentally, except for the "lump" and limitation of movements of the head due to it. Her parents appeared normal, and so did her younger brother and sisters. The "lump" was readily recognized as an elevated and rotated scapula and the diagnosis of Sprengel's deformity about to be entered. But there was something striking in the fact that, for a thin girl, the patient had an uncommonly short, thick neck. This, with the cervical and upper dorsal scoliosis and limitation of movements of the head in all directions, led to further investigation. Roentgenograms of the cervical spine (Figs. 2 and 3) revealed the true nature of the affection. There was no restriction of movements of the mouth, nor any other deformities or anomalies.

BIBLIOGRAPHY

1. Bauman, G. I.: Absence of the Cervical Spine: Klippel-Feil Syndrome. J. Am. Med. Assn., XCVIII, 129, 1932.
2. Böhm, Max: Angeborener Ossärer Schiefhals. Zentralbl. f. Chir., LVIII, 2019, 1931.
3. Crouzon, O., et Liège, R.: Constitution Anatomique de la Colonne Vertébrale dans le Syndrome de Klippel-Feil. Bull. et Mém. Soc. Méd. d. Hôp. de Paris, LII, 917, 1928.
4. Ingelrans, P., et Piquet, J.: Syndrome de Klippel-Feil Accompagné de Malformations Multiples. Rev. d'Orthop., XV, 297, 1928.
5. Klippel, M., et Feil, A.: Anomalie de la Colonne Vertébrale par Absence des Vertèbres Cervicales; Cage Thoracique Remontant jusqu'à la Base du Crâne. Bull. et Mém. Soc. Anat. de Paris, LXXXVII, 185, 1912.

   Un Cas d'Absence des Vertèbres Cervicales avec Cage Thoracique Remontant jusqu'à la Base du Crâne (Cage Thoracique Cervicale). Nouvelle Iconog. de la Salpêtrière, XXV, 223, 1912.
6. Meisenbach, R. O.: Absence of the Cervical Spine; Report of a Case. Am. J. Orthop. Surg., X, 647, May, 1913.
7. Monestier, Georges: Des Signes Radiologiques du Syndrome de Klippel et Feil à Propos de Deux Cas Nouveaux de Cette Malformation. Thèse de la Fac. de Méd. de Paris, 1925.
8. Noble, T. P., and Frawley, J. M.: The Klippel-Feil Syndrome; Numerical Reduction of Cervical Vertebrae. Ann. Surg., LXXXII, 728, 1925.
9. Frawley, J. M.: Congenital Webbing. Am. J. Dis. Child., XXIX, 799, 1925.
10. Petresco-Poissonnier, Valérie: Contribution à l'Étude du Syndrome de Klippel-Feil. Thèse de la Fac. de Méd. de Paris, 1922.
11. Sever, J. W.: Congenital Anatomical Defects of the Spine and Ribs. Boston Med. and Surg. J., CLXXXVI, 799, 1922.

INTERMITTENT HYDRARTHROSIS OF THE KNEE JOINT

A Report of Two Cases Apparently Cured by Synovectomy, together with Pathological Findings

BY ARTHUR KRIDA, M.D., F.A.C.S., NEW YORK, N. Y.

Synonyms: Hydrops articulorum intermittens; Hydrops intermittens; Hydrops genu intermittens; Hydrarthrose intermittens des genoux; Intermittierende Gelenkswassersucht; Typisch recidivierender Hydrops genu; Periodische Gelenkschwellung; Hydrops hypostrophos.

Definition: The term "intermittent hydrarthrosis" signifies a chronic condition in which repeated joint effusions occur, each of several days' duration, refractory to salicylates, unaccompanied by pronounced inflammatory manifestations, cardiac disease, or joint deterioration, and recurring in the main at regular intervals (Schlesinger [1]).

HISTORY

Perrin [2] is credited with the first case report in 1845. Moore [3], [4] reported the next two cases, in 1864 and 1867. Benda [5] exhaustively reviewed fifty-five cases in 1900, and reported two cases, Linberger [6] reviewed the literature in 1901, and reported two cases. Schlesinger [7] in 1903 was able to collect sixty-five cases, and added two cases of his own. Bierring [8] in 1921, collected seventy-six cases and added one. Schlesinger [1] in 1926 stated that about 100 cases existed in the literature. This number would be materially reduced if his own criterion as to what constitutes the condition were applied in the evaluation of the reported cases.

APOLOGIA FOR THE REPORT OF TWO CASES

The report of additional cases of this curious condition, except to augment statistical material, would hardly be of interest, unless a distinct contribution to the subject be demonstrated.

The writer here reports two cases, in which for the first time excision of the synovial membrane (synovectomy, Swett [9]) was performed, and in which for the first time a suitable opportunity for the study of the pathological changes in the synovial membrane was afforded.

GENERAL CHARACTERISTICS AND SYMPTOMATOLOGY

The knee joint, more often singly, but frequently bilaterally, is practically invariably involved, rarely in association with other joints. The condition is characterized by a periodically recurring effusion into the affected joint or joints of several days' duration, followed by an interval during which the joint rapidly assumes its functional integrity and becomes symptom-free.

The intervals of freedom vary from seven to twenty-one days, rarely exceeding those limits. The typical interval is eleven or twelve days. The periodicity is not invariable in the individual case, except that a definite periodicity is encountered in relatively long periods of time, during which, if more than one joint be affected, each joint is apt to maintain its own periodicity. Time and circumstance may alter the extent of the effusion and also the intervals between attacks.

The stage of effusion is usually moderately uncomfortable to the patient, and the disability and such restriction of movement as may be present are occasioned by the distention of the joint. When both knee joints are affected simultaneously, the disability is of course more pronounced. In some individuals, the stage of effusion is accompanied by a good deal of pain, and constitutes a major disability.

The effusion is not accompanied by the signs which one associates with an active inflammation of a joint. There is little or no increased heat, no infiltration nor muscle spasm, no tenderness, and no constitutional reaction. The distention of the joint is evident upon palpation.

With regard to duration, it may be stated that the condition persists for years, and is liable to recurrences after intervals of freedom. Blanc [10] recites a history of twenty-two years' duration.

The clinical picture is striking; there can be no confusion with other joint-disease entities. Treatment has, on the whole, been exceedingly unsatisfactory.

ETIOLOGY

While the general symptomatology of the condition may be easily described and is generally understood, the etiological factors concerned in its development are not so clear. The complicated factors which are involved in the etiology of intermittent hydrarthrosis remain to be evaluated. Such an evaluation of etiological factors is attempted in the summary which follows.

1. *Age.* Intermittent hydrarthrosis occurs predominantly in the third and fourth decades. Of fifty-seven cases, one had its onset at seven; seven between ten and fifteen; nine between fifteen and twenty; eighteen between twenty and thirty; thirteen between thirty and forty; four between forty and fifty; two between fifty and sixty years of age. In three cases the age was not stated (Benda [5]).

2. *Sex.* The incidence in the sexes is practically equal. In Schlesinger's [7] series there were thirty-two males and thirty-five females.

3. *Race.* All reported cases have occurred in whites.

4. *Heredity.* With the exception of Blanc's [10] report of intermittent hydrarthrosis occurring in mother and daughter, there is little to indicate a background of heredity. In both mother and daughter the left knee was involved, and the periodicity of the attacks was the same. Schlesinger [1] reports the case of a woman with intermittent hydrarthrosis, one of whose two brothers, both sisters, and one cousin were similarly affected, the periodicity in each case being the same.

5. *Trauma.* That trauma plays an important rôle in a considerable percentage of cases is evident from a perusal of the reported cases. In Moore's [3] first case, the condition developed after unaccustomed scrubbing of stone steps; a loose body in the knee joint was present. A loose body was present also in his second case. Grandidier [11] reports a typical case in a woman of fifty-four which followed a severe fall on the knee. There are numerous other reported instances in which a definite trauma antedated the development of the condition; in this group must be included the writer's first case. Over one third of the cases had a reasonably laborious occupation.

6. *Infection.* The only case on record in which a direct connection between intermittent hydrarthrosis and a general infection has been established by bacteriological methods is Baker's [12] remarkable case of undulant fever. In this there was a typical intermittent hydrarthrosis syndrome affecting both knees, and of seven months' duration. An organism of the Brucella melitensis group was recovered from the blood stream, from the urine, and from the joint effusion. The use of a vaccine made from the organism resulted in a cure of the undulant fever, but only temporary amelioration of the hydrarthrosis.

In Pulawski's [13] case, an attack of typhoid fever had the apparent effect of establishing a definite periodicity in what was, prior to that infection, an irregularly recurrent hydrarthrosis. He reports finding an encapsulated coccus similar to the pneumococcus in smears of the joint effusion, but did not succeed in growing it on media.

7. *Arthritis.* The association of intermittent hydrarthrosis with "rheumatism" and rheumatoid arthritis has been frequently noted. These cases should be divided into two groups: (1) those in which there is a previous history of "rheumatism" or of inflammatory joint affections of undetermined character, with recovery without joint deterioration, and (2) those in which there was associated a concomitant rheumatoid arthritis.

In the first of these groups, a few case reports relate antecedent "rheumatism". Thus in Billroth's [14] and in Weisz's [15] single cases, a gonorrhoeal infection antedated the attacks. In Bierring's [8] case there was a well defined history of rheumatic fever.

In the rheumatoid arthritis group, periodic effusions have occasionally been noted. Garrod [16] reported eight cases of intermittent hydrarthrosis, five of which he classed as of the symptomatic type, in the course of, and with the persistence of, the rheumatoid disease. Hartmann [17] reported a very atypical case occurring in the course of wide-spread joint involvement with rheumatoid disease. Breslauer's [18] case is slightly better in this regard.

It must be stated here that the cases in the above mentioned group, while they may exhibit a certain periodicity of joint effusion, may be challenged for inclusion in the general group of intermittent hydrarthroses.

8. *Menstruation and Pregnancy.*

FIG. 1
Gross appearance of the tissue from Case 1.

Menstruation. In only a single case has an approximate parallel been drawn between the menstrual cycle and intermittent hydrarthrosis. Senator [19] reports a case in which attacks of somewhat variable periodicity, but commonly associated with menstruation, began one year after the onset of that function. However, in the second case reported in the present paper, a very definite association of the cycles of hydrarthrosis and menstruation was encountered.

The Influence of Pregnancy. Canonne [20] reports the first case in which pregnancy was a direct factor. Six weeks postpartum there occurred an inflammation of the ankle joint; during its recrudescence the right knee became the seat of an effusion which recurred at fourteen-day intervals. Panas [21] reports the onset of the condition in a young woman six months postpartum. The condition persisted until she again became pregnant four years later, and recurred eleven days after abortion at seven months. In Blanc's [10] report of two cases, the mother, after childbirth, exhibited an intermittent hydrarthrosis which lasted twenty-two years. Paus [22] reports a case of nine years' duration, which developed six months after the first labor. Fridenberg [23] reports a case of seven years' duration which intermitted entirely during two pregnancies.

9. *Neuropathic Predisposition.* Féré [24] has reported five very atypical cases in which psychic factors would seem to have played a rôle. Bum [25] reports the case of a young neurasthenic male in whom an intermittent hydrarthrosis of the right knee joint developed.

10. *Sensitization,* association with vasomotor disorders (Quincke).

In 1924 [26] Miller and Lewin reported the case of a man who had had the condition for sixteen years, and was apparently cured by desensitization with intravenous typhoid vaccine injections, continued over a period of some months. Urticaria developed after each injection. The association with asthma has occasionally been noted, as in Burchard's [27] case, in which the asthma alternated with the intermittent hydrarthrosis. Schlesinger and also Garrod would like to ally the condition with angio-

FIG. 2

Section shows flattened villi with marked round-cell infiltration. Low power from Case 1. The operation in this case was done during the height of the attack.

neurotic oedema, although the number of such reported cases is quite small, and the association not well defined.

11. *Unknown Etiology.* This group contains the larger number of cases in which no precise etiology could be established.

PROGNOSIS

All observers agree that the prognosis in the average case is not good, but that sometimes, with or without treatment, or despite treatment, the attacks will cease. Sometimes the attacks may cease in the affected joint, and the periodicity be transferred to another joint. Occasionally, a recurrence of the cycle may take place after a long interval of freedom.

TREATMENT

Treatment on the whole has not been satisfactory. Quinin and arsenic have been extensively used, seldom with success. Rest and splintage are of no avail, which is true also of the various physiotherapeutic measures. Aspiration has been frequently applied, without affecting the course of the condition. Aspiration and lavage followed by iodoglycerin injections are reported to have been successful in two cases. Iodin and carbolic acid solutions are reported to have resulted in improvement in two cases. Arthrotomy, with evacuation of the exudate, is reported as having been curative in one case. On the other hand, Nielson [28] reports a case in which two arthrotomies were done without relief.

Case 1. Male, aged twenty-six, Lithuanian parentage, married. Referred by Dr. E. M. Nash, Chief Surgeon, New York State Insurance Fund, on December 23, 1930.

Seven months previously he had been struck in the upper portion of the left calf by a falling plank. He was in bed at home for three weeks. At the end of that time he appeared to be quite well and he returned to his work as a plumber. Two weeks later, on a Monday, he experienced a drawing sensation at the back of the left knee. On Tuesday, the knee was swollen. On Wednesday, the swelling subsided.

On alternate Mondays since that time, this cycle of events has recurred. The attacks invariably began with a drawing sensation in the calf and a sense of tightness in the knee joint. On Tuesday morning the joint was distended and uncomfortable. On Wednesday the swelling and discomfort gradually abated, and on Thursday the joint appeared to be quite fit for the demands which his occupation made upon it.

Upon examination, which happened to coincide with the episode of effusion, the joint was found to be moderately distended with fluid, which limited the range of motion moderately. There was no increased heat, and no tenderness. An indefinite thickening could be felt in the upper third of the calf, evidently imbedded in the substance of the muscle.

The patient was admitted to the Hospital for the Ruptured and Crippled on a Wednesday, five weeks later. The joint was aspirated; the Wassermann reaction of the blood and of the joint fluid was negative. The joint fluid was clear, and not abnormal in cellular constituents. The chemical examination of the blood showed that the blood sugar, uric acid, and urea nitrogen were within normal limits. The blood count was normal; the blood pressure 135/70.

The patient was purposely kept in bed in order that the next cycle might be observed under conditions of complete rest. On the second Monday afternoon he began to have some discomfort in the calf and a sense of tightness in the knee. On Tuesday morning the joint was, as usual, distended with fluid. Fifty cubic centimeters of clear

fluid was aspirated, and of this amount eight cubic centimeters was reinjected subcutaneously (autoserotherapy). There was no effect upon the course of the cycle.

An exhaustive sensitization study was then made by Dr. Will Cook Spain. Intracutaneous tests of 137 substances and organisms failed to show any reaction. The substances tested for are detailed below:

Milk
Egg
Wheat
Barley
Rice
Oats
Rye
Cornmeal
Buckwheat
Veal
Chicken
Beef
Turkey
Pork
Lamb
Goose
Coffee
Tea
Chocolate
Black pepper
Nutmeg
Allspice
Clove
Mustard
Cinnamon
Honey
Vanilla
Lettuce
Cucumber
Radish
Celery
Navy bean
String bean
Corn
Asparagus
Sweet potato
Cabbage
Lima bean
White potato
Squash
Spinach
Green pea
Cauliflower
Turnip
Onion
Beet
Carrot
Tomato
Mushroom
Pineapple
Grape
Orange
Raisin
Grapefruit
Apple
Fig
Cantaloup
Rhubarb
Pear
Lemon
Banana
Prune
Strawberry
Blackberry
Apricot
Plum
Raspberry
Cherry
Peach
Pecan
Almond
Peanut
Chestnut
English walnut
Cocoanut
Smelt
Codfish
Salmon
Crab
Lobster
Shrimp
Bluefish
Haddock
Clam
Flounder
Scallop
Mackerel
Herring
Halibut
Oyster
Timothy
Ragweed
Orris
Dust
Dog epidermis
Cat epidermis
Goose epidermis
Chicken epidermis
Duck epidermis
Rabbit epidermis
Horse epidermis
Horse serum
Tobacco
Le Page
Sheep's wool
Silk
Black flag
Cottonseed
Staphylococcus aureus
Staphylococcus albus
Pneumococcus IV
Pneumococcus II
Micrococcus catarrhalis
Bacillus influenza
Streptococcus hemolyticus
Streptococcus non-hemolyticus

At the height of the subsequent attack on Tuesday, February 17, 1931, operation was done. The joint was opened by what has been described by the writer [29] as the "general utility incision for exploration of the knee joint," under tourniquet. This incision extended from the top of the quadriceps pouch in the mid-line downward, sweeping around the inner margin of the patella, then alongside the patellar tendon, to the tibial tubercle.

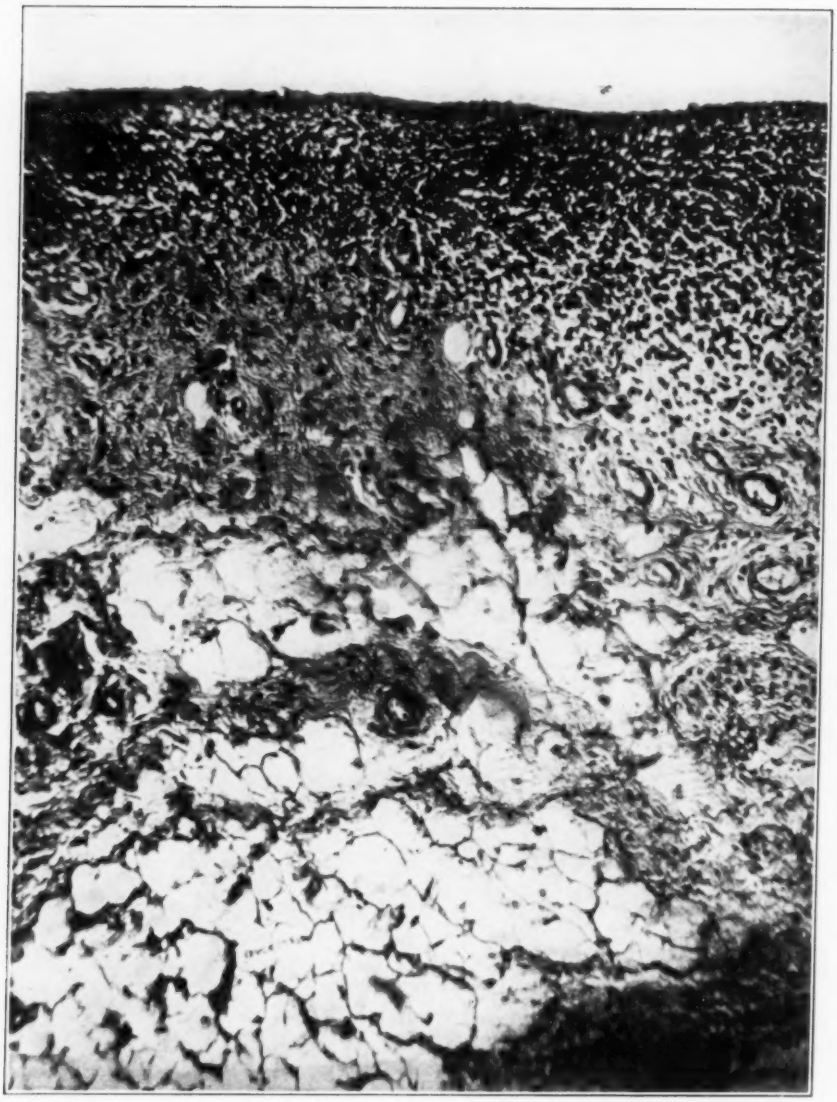

FIG. 3

Shows intense round-cell infiltration of the synovial membrane.

Operative Findings

Upon opening the joint, a considerable quantity of thin rather deep yellow fluid was evacuated. The synovial membrane was thickened about one-quarter of an inch, and presented several tab-like projections. It was pale pink in color. The infrapatellar fat pad was enlarged, and the synovial membrane covering it had a similar pale pink appearance. The articular cartilage of the patella presented a rather diffuse superficial fibrillary degeneration, evidently of traumatic origin.

The synovial membrane was thoroughly excised; the fat pad was excised. Bleeding points were much more numerous than usual, and such were ligated. The joint was closed in layers.

FIG. 4

High-power photomicrograph of an area in Fig. 3, demonstrating the round-cell infiltration and the marked oedema. (× 440.)

A second incision was made over the upper portion of the calf. Beneath the deep fascia, and imbedded in the muscle, was an ill defined mass about two by three-quarters inches, of tough fibrous consistency, and presenting several brownish stains, evidently of hematogenous origin. This was excised.

There was rather more postoperative reaction than is usual. The man was allowed to walk on the sixteenth day, then having had no evidence of any degree of recurrence of the previous cycle of effusion. The range of motion gradually returned. At the end of three months he returned to his work, having at that time a range of motion to well beyond a right angle.

One year after operation, there had been no further disability nor any recurrence of effusion.

The second case is from my service at Bellevue Hospital, and was operated upon by my associate, Dr. Paul C. Colonna.

FIG. 5

Section through the fibrous mass from the calf muscle.

CASE 2. Female, aged nineteen, single. Six years before, patient had an illness with fever and prostration which confined her to bed for two weeks. One month after her recovery the right knee swelled up and remained swollen for four or five days. In the course of one year she had frequent recurrences of the swelling for four or five days, but with no regularity. At the end of one year the left knee began to swell up in a similar manner. For six months this series of events continued in both knees. The right knee apparently got well, but the swelling remained in the left until her menstrual periods began at the age of sixteen, when, one month after the first period, the recurrent swelling took on a two-week cycle. After six months of menstrual periods she had an amenorrhoea of six months during which time she had no trouble with her knee, but on

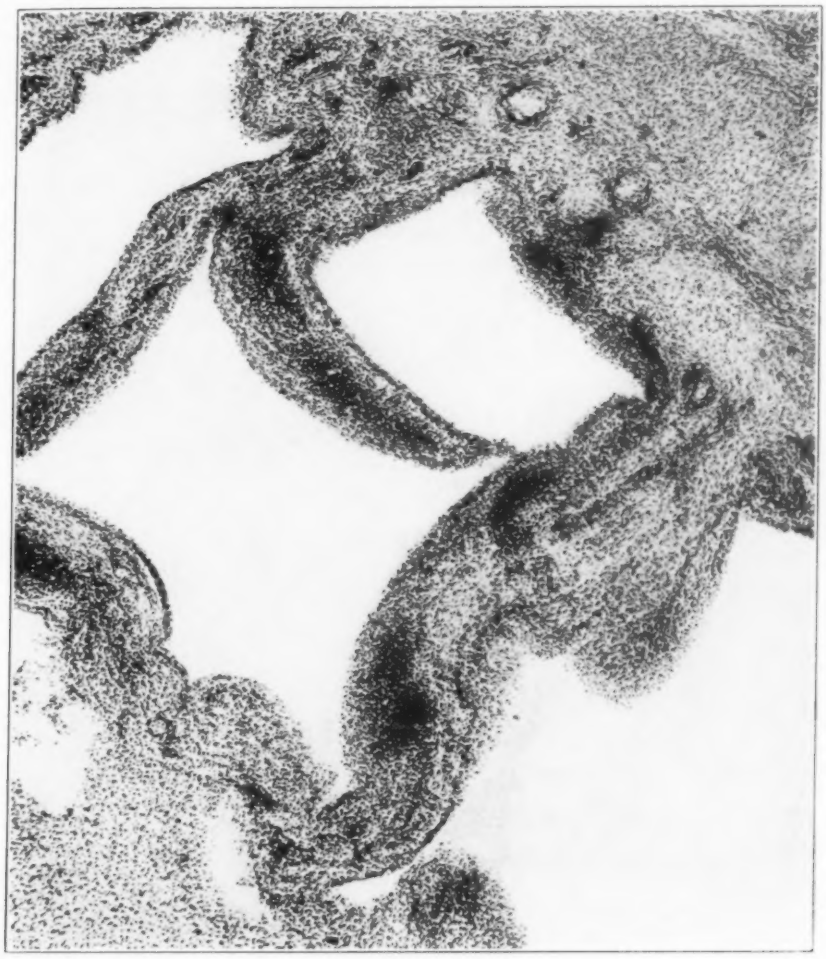

FIG. 6

From the second case, showing the slender slanting villi. This operation was done in a quiescent interval.

resumption of menstruation the former periodicity recurred. This cycle continued for one year, when, without cause, the cycle changed to eleven days.

Ten months previously she had had both semilunar cartilages removed at another hospital, without any effect on the swelling or periodicity. She had likewise had aspirations without any effect.

On July 8, 1931, during a quiescent interval, the left knee joint was opened by the general utility incision. A congested synovial membrane was excised, and the joint was closed in layers.

The postoperative course was uneventful, except that a considerable restriction of movement remained, which was somewhat improved by a subsequent manipulation under anaesthesia. Eight months after operation, the joint movement was from 180 to 120 degrees; there had been no recurrence of the effusion in either knee.

The report of the microscopic pathology as made by Dr. John E. MacWhorter was as follows:

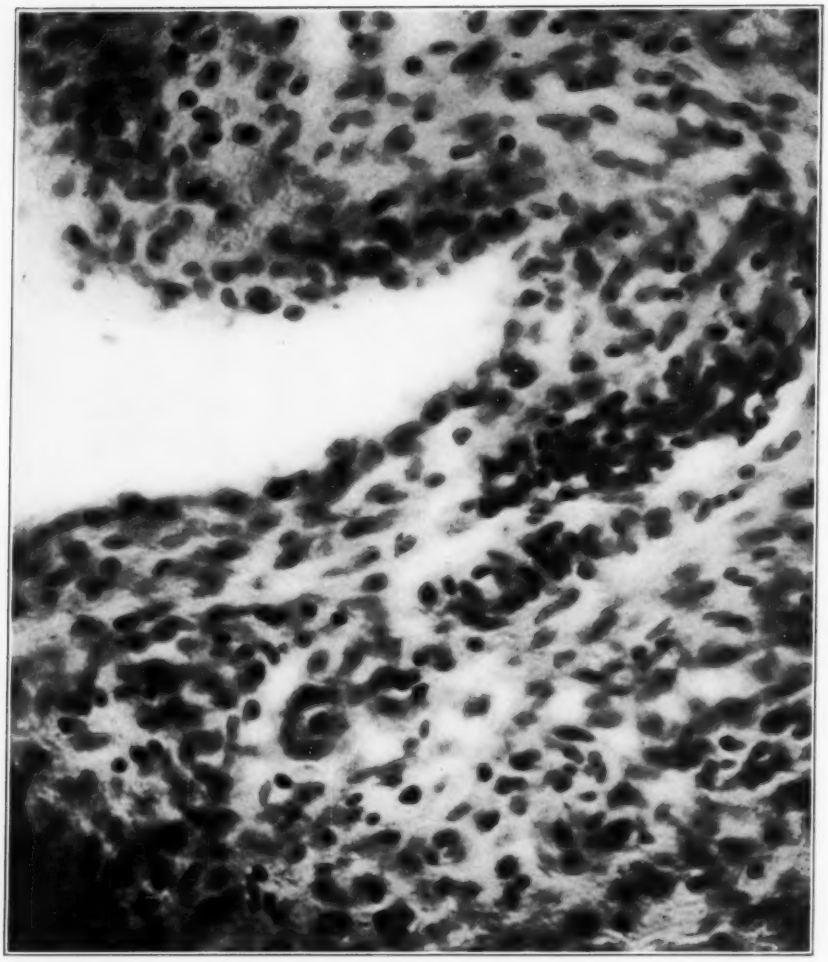

FIG. 7

High-power photomicrograph of the synovial membrane from Case 2.

Case 1

"Surg. Path. No. 858, Hospital for the Ruptured and Crippled. The sections show that the synovial surface is arranged in the form of somewhat flattened villi. The villi are made up largely of rather recently formed granulation tissue which is characterized by many endothelial line blood spaces and young connective-tissue cells of the fibroblastic type. The tissue as a whole is rather strikingly oedematous. There is a diffuse and profuse infiltration with lymphocytes in the villi and in the tissue immediately below the synovial surface.

"The rest of the section is made up of dense connective tissue, adult fat, and many sclerotic blood vessels.

"The small tumor mass from the calf consists of dense connective tissue and cartilage.

Case 2

"Surg. Path. No. 1949/31, Bellevue Hospital. Sections show the synovial surface covered with villi which for the most part are long, slender and branching. Structurally

they are made up of fairly firm, moderately adult connective tissue and rather thick-walled blood vessels. This tissue as a whole is only slightly oedematous, and is but moderately infiltrated with round cells. The round-cell infiltration is confined almost entirely to the villi.

"The rest of the section consists of dense connective tissue, fat, and thick blood vessels.

Remarks upon the Comparison of Sections from the First and Second Cases

"The manner in which the two sections differ is this: sections of the first case are characterized by flattened villi, recently formed granulation tissue, oedema, and very profuse round-cell infiltration.

"The second case is characterized by long, slender villi, well formed connective tissue, only slight oedema, and very moderate round-cell infiltration.

"In the first case, there is present an active process; in the second, the picture is one of inactivity."

SUMMARY AND CONCLUSIONS

Intermittent hydrarthrosis in general has hitherto been regarded as a medical curiosity of unknown pathogenesis and in which treatment has been decidedly unsatisfactory.

Two typical cases of intermittent hydrarthrosis of the knee joint, of diverse etiology, are reported in which apparent cure was obtained following the operative removal of the synovial membrane.

The etiology in the first case was definitely traumatic, and the condition was associated with a fibrous tissue mass in the calf muscle, the probable origin of this mass being a hematoma of that region. The attacks were of nine months' duration, came on five weeks after the traumatism, and persisted despite aspiration, rest in bed, and autoserotherapy. No clinical hypersensitiveness could be demonstrated in the history or by exhaustive tests.

The etiology in the second case was obscure, but definitely related to menstruation. The semilunar cartilages had been removed at another hospital. She had had repeated aspirations without effect.

Despite the fact that rarely recurrences of this disorder may take place after long intervals, it is nevertheless felt that, on the basis of the above observations, synovial excision offers the best prospect for the cure of the condition.

BIBLIOGRAPHY

1. Schlesinger, H.: Ueber den Hydrops Articulorum Intermittens und seine Familiäre Form. Wiener Klin. Wchnschr., XXXIX, 68, 1926.
2. Perrin, E. R.: Cas Curieux de Contracture Partielle Intermittente, à Type Octane, avec Irritation Violente et Épanchement de Sérosité dans Plusieurs Articulations. L'Union Médicale, XXV, 821, 1878. (Original reference: J. de Médecine, III, 82, 1845.)
3. Moore, C. H.: Periodical Inflammation of the Knee-Joint. Lancet I, 485, 1864.
4. Moore, C. H.: Two Cases of Periodical Inflammation of the Right Knee Joint; With Remarks. Trans. Medico-Chir. London, L, 21, 1867.
5. Benda, Th.: Intermittirende Gelenkwassersucht. Monographische Studie. Allg. Med. Centr.-Ztg. LXIX, 471, 483, 496, 508, 521, 1900.
6. Linberger, A.: Ueber Intermittierenden Gelenkhydrops. Beitr. z. Klin. Chir., XXX, 299, 1901.

7. Schlesinger, H.: Die Intermittirenden Gelenkschwellungen. Vienna, A. Holder, 1903. (Nothnagel's Specielle Pathologie und Therapie, VII, Teil 3.)
8. Bierring, W. L.: Intermittent Hydrarthrosis. J. Am. Med. Assn., LXXVII, 785, 1921.
9. Swett, P. P.: Synovectomy in Chronic Infectious Arthritis. J. Bone and Joint Surg., V, 110, Jan. 1923.
10. Blanc: Observation d'Hydrarthrose Intermittente Héréditaire. Loire Méd., XVII, 287, 1898.
11. Grandidier: Ueber Hydrops Genu Intermittens. Berliner Klin. Wchnschr., IX, 266, 1872.
12. Baker, B. M., Jr.: Undulant Fever Presenting the Clinical Syndrome of Intermittent Hydrarthrosis. Arch. Int. Med., XLIV, 128, 1929.
13. Pulawski, A.: Ein Fall von Periodischer Gelenksschwellung. (Hydrops Articulorum Intermittens.) Wiener Klin. Wchnschr., XXVII, 421, 1914.
14. Billroth, C. A. T.: Typisch Recidivierender Hydrops Genu. *In* Die Allgemeine Chirurgische Pathologie und Therapie. Ed. 8. Berlin, 1876.
15. Weisz, Eduard: Ueber Hydrops Articulorum Intermittens. Berlin, Fischer, 1898. (Berliner Klinik, Heft 119, Mai, 1898.)
16. Garrod, A. E.: Concerning Intermittent Hydrarthrosis. Quart. J. Med., III, 207, 1910.
17. Hartmann, G.: Ueber einen Fall von Spondylitis Deformans mit Intermittierendem Hydrops der Gelenke unter Berücksichtigung der Kalkausscheidung durch den Harn. Königsberg i. Pr., M. Liedtke, 1889.
18. Breslauer, L.: Ist der Chronische Gelenkrheumatismus eine Nervenkrankheit? Wurtzburg, Gleiwitz, Schönwolff und Proske, 1889.
19. Senator, H.: Ueber Intermittirende Gelenkwassersucht. Charité-Ann., XXI, 224, 1896.
20. Canonne, N.: De l'Hydrarthrose et des Avantages de l'Immobilité dans son Traitement. Thèse de Paris, No. 53, 1867.
21. Panas: Double Hydrarthrose Intermittente des Genoux. Bull. et Mém. Soc. de Chir. de Paris, IV, 240, 1878.
22. Paus, N.: Intermittent Hydrops of Knee. Norsk. Mag. f. Laegevidensk., LXXXV, 760, 1924.
23. Fridenberg, A. H.: A Rare Form of Vasomotor Disease. A Contribution to the Study of Hydrops Intermittens Articulorum. Med. Rec., XXXIII, 657, 1888.
24. Féré, Ch.: Contribution à l'Histoire des Hydarthroses Intermittentes. Rev. Neurol., I, 465, 1893.
25. Bum, A.: Hydrops Genu Intermittens. (Wiener Briefe.) Münchener Med. Wchnschr., XLVI, 237, 1899.
26. Miller, J. L., and Lewin, P.: Evidence of the Anaphylactic Character of Intermittent Hydrarthrosis. J. Am. Med. Assn., LXXXII, 1177, 1924.
27. Burchard, O.: Ueber Intermittirende Gelenkwassersucht. Deutsche Med. Wchnschr., XXVIII, 380, 1902.
28. Nielson, A. L.: Intermittent Hydrarthrosis. J. Am. Med. Assn., LXXVIII, 507, 1922.
29. Krida, A.: A General Utility Incision for Exploration of the Knee Joint. J. Bone and Joint Surg., XXIII, 212, Jan. 1925.

THE BIFURCATION OPERATION *

A Study of Late Results

BY CHESTER S. LOWENDORF, B.S., M.D., YOUNGSTOWN, OHIO

The bifurcation operation, because of the simplicity and rapidity by which it may be performed, is not a formidable procedure. It should not, however, be used indiscriminately for all hip diseases. But, when the dangers of extensive operations become too threatening, it may be used as a substitute for the more anatomical reconstructions.

This report concerns the late results from fourteen cases in which the bifurcation operation was performed in the Orthopaedic Department of the State University of Iowa. It is hoped that the analysis will aid in indicating the advantages and the limitations of this palliative method.

Indications

The bifurcation operation was performed first in cases of irreducible congenital dislocation of the hip, when no other means was available for placing the femur firmly underneath the bony pelvis. Since then the field has been enlarged to include ununited fractured neck of the femur, osteo-arthritis of the hip, suppurative arthritis with pathological dislocation. Others have also included quiescent tuberculous hips and Charcot hips; but we do not make these indications for reasons that will be brought out later. Among these various conditions we are faced with a common symptomatology that requires urgent relief. Uniformly we find pain on motion, instability upon weight-bearing, and deformity.

Other reconstructive measures alleviate these symptoms in these hip conditions, but such operations entail an additional risk which the general status of the patient may not permit. It has been shown that the more extensive operations carry a greater risk. In an analysis of our Whitman reconstruction operations, which was recently published, it was found that only seven of sixteen patients had an uneventful convalescence. There was no shock following any of our bifurcation operations. Elderly patients with hypertension, arteriosclerosis, and nephritis are usually considered poor surgical risks. Yet among the patients of this series there were two with a systolic pressure of 200 and several with marked arteriosclerosis. One patient was sixty-seven years old. The average age of those operated upon for non-union of fractured neck of the femur and osteo-arthritis of the hip was fifty-eight. The bifurcation operation carries so little danger that it can be performed on patients where other operations might be contra-indicated.

The amount of bony tissue still available for weight-bearing is another important factor in considering operative indications. The average length of time before operation, in our patients with fractured neck of the

* From the Department of Orthopaedic Surgery, State University of Iowa, Iowa City, Iowa.

femur, was nine months. During this time the neck had partially or completely absorbed. The head and most of the neck were destroyed in suppurative arthritic cases of this series. Under such circumstances anatomical reconstruction is nearly impossible.

Contra-Indications

In this clinic, we have had only two cases of Charcot hip and two cases of quiescent tuberculous hip upon which the bifurcation operation has been performed. This is too small a number for giving a definite opinion in opposition to opinions based on larger series. However, since both tuberculous patients developed sinuses that have been open for years, and since, in both cases of Charcot hip, the acetabula disintegrated progressively above the supporting fragment of the femur, again leaving no bony support, we would naturally hesitate to recommend the operation in these conditions.

It has been mentioned elsewhere that the bifurcation operation is a simple arthroplasty, a pseudarthrosis between the pelvis and femur with the former capsule as the interposing tissue; nevertheless, this operation can not be performed upon ankylosed hips; the entire femur must be movable in order that the proper results may be obtained. This operation will not in any case increase the motion over that already present.

Complications

To prevent most of the possible complications, strict attention must be paid to the details of the operation. Probably the most common complication is unnecessary shortening. This may occur if the osteotomy is performed too low on the shaft of the femur. Then, in order to obtain bony support, considerable displacement becomes necessary. The possibility of injury to femoral vessels appears great to many observers. Yet, among our own cases and in those of the literature, we find no evidence that such a complication has actually occurred. Care in the selection of site of osteotomy and in the manipulation following osteotomy, during which one guards against hyperextension, is all that is required to prevent such a disaster.

While it is common knowledge that fractures in and about the intertrochanteric region usually heal with bony union, still non-union may occur. This complication has occurred in a very small percentage of cases recorded in the literature. We have had only one case of non-union and that occurred in a patient with a tuberculous hip, who also developed a persistently draining sinus.

Failure to have the femur support the pelvis is due to failure to properly perform the operation. Infinite care must be exercised, so that the osteotomy is not too high on the femur and so that the displacement of the lower fragment is accomplished; otherwise, the necessary bifid effect is never obtained. If the osteotomy should be placed too high, then the lower fragment, following displacement, would not abut the bony surface

of the pelvis. If no or improper displacement should occur, then the femur would also fail to fall under the weight-bearing line. Such errors in technique occurred in five cases among our original list, and, since they were really not bifurcation operations to begin with, they have been excluded in this study.

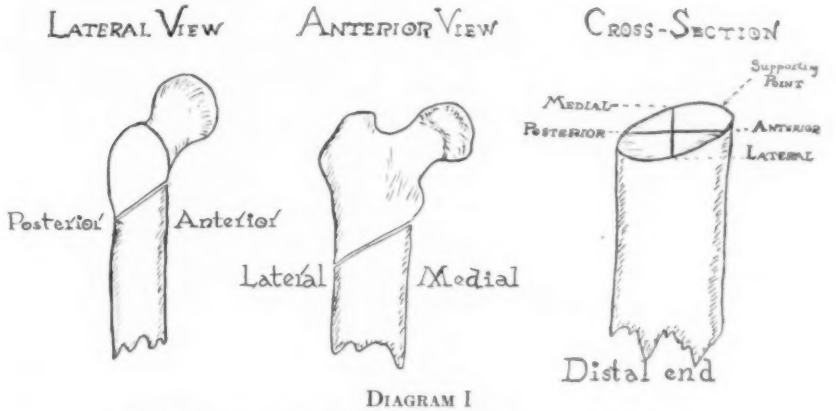

DIAGRAM I

The direction of the osteotome and the plane of osteotomy.

Procedure

The principles of this operation are exceedingly simple. However, one must recognize that exact knowledge of every phase of the operative technique is necessary and that this technique must be applied with the utmost precision. It is with this fact in mind that I repeat the details of the operation, which has already been described in the literature.

First of all, one plans the location of the osteotomy with the aid of the x-ray plate. In order to do this properly, the exact point on the pelvis, which is to receive the support of the femur, must be determined. This pelvic point of support varies with each individual and with the pathological condition present. It, therefore, may be the center of the acetabulum, as in the case of a dislocated femur, or the lower border of the acetabulum, or the lower edge of the head, as in ununited fractured neck of the femur or osteo-arthritis of the hip. The next step in determining the location of the osteotomy is to decide where the supporting point of the femur should come. This point, on the roentgenogram, is a point on the medial side of the femur, horizontally opposite the above mentioned point on the pelvis. If this femoral point should be too low, then unnecessary shortening would result. The relation of this point to other structures is of no importance. As Hass states, "The site of osteotomy according to the femoral head varies, but is decided quite accurately in every instance". One is now ready to draw a line on the roentgenogram, obliquely downward and laterally across the shaft of the femur. The degree of angulation required is approximately forty-five degrees or less. In order to properly carry out such well laid plans during the operation, a probe may

FIG. 1

R. F., aged fifty-five, fracture. Bifurcation intertrochanteric, no pain, negative Trendelenberg, good motion, no increased shortening. Good result. Final roentgenogram.

be bent from the tip of the greater trochanter down along the shaft and along the proposed site of osteotomy. This probe may be sterilized and inserted over the femur at operation.

At operation the patient is placed on the opposite side, so that the operative field shall be above. A linear incision is made over the lateral surface of the femur so as to expose the tip of the greater trochanter and several inches of the shaft. After the periosteum has been elevated, the probe is placed in the wound approximately in the same manner that it had been on the roentgenogram. Thus, the beginning and the angulation of the osteotomy line are established. However, the osteotomy is formed obliquely in the frontal, sagittal, and tranverse planes. Therefore, the osteotome must be rotated so its anterior border is superior to its posterior border, while at the same time it is tilted in order to be driven in and up. In other words, the chisel travels from lateral, distal posteriorly to median, proximal anteriorly. The result will be a large, elliptical raw surface (See Diagram 1). The femoral point for supporting the pelvis is in reality the anteromedian pole of the ellipse. The need for an ellipse with an anteromedial direction is not obvious. It is clear that an oblique osteotomy with the point anterior would be useless; but one must remember also that the shaft of the femur is not in the same frontal plane as the head. There is normally about twenty-five degrees of anteversion to the neck of

the femur, and the axis of the head of the femur runs forward, upward, and inward with respect to the shaft. Since the shaft is behind the acetabulum, normally and under pathological circumstances, the anterior angulation, or the tilt in the sagittal projection of the osteotomy, is quite necessary. The degree of anterior tilting of the osteotomy varies, accordingly, as to whether the acetabulum is empty or contains the femoral head.

After the osteotomy is completed, the thigh is abducted with one hand, while the upper portion of the lower fragment is pressed medially with the thumb of the other hand. Upon this manipulation the shaft of the femur glides past its upper fragment. When the femur has been displaced a fraction of an inch, one will note that it will override no further for it now rests underneath the bony ledge of the pelvis. The wound is then closed in layers.

The patient may now be carefully turned on his back in order to apply a plaster cast. The extremity is placed in abduction, which varies from thirty degrees in cases of ununited fractured neck of the femur to fifteen degrees in cases of osteo-arthritis. Slight internal rotation is advisable, since there is a tendency to develop an external rotation deformity. The thigh is left in neutral position in the sagittal plane, special care being taken to prevent hyperextension. It is customary in this clinic to apply a double hip spica with a short torso, instead of a high single spica, since the former allows greater freedom of the chest and abdomen.

The ordinary postoperative care is required. The patient remains in his first cast six weeks to two months. Then, according to the roentgenographic evidence of the degree of bony fusion, another single hip spica is applied, and the patient is allowed on crutches but without weight-bearing; or physiotherapy is instituted for another month. In approximately three months the patient gradually commences weight-bearing.

Fourteen bifurcation operations were available for study in this series; they have been personally observed over an average period of twenty-seven months. These operations had been performed by Dr. Steindler and his staff. Excluded are only the atypical osteotomies with their various individual modifications.

The immediate postoperative convalescence in these cases was uniformly uneventful. No shock occurred following the operation. There was no circulatory disturbance due to the operation. Pneumonia developed in one patient who was an exceedingly poor risk and presented bilateral Charcot hips, a Charcot ankle, and tabes dorsalis.

The relationship of the osteotomy site with the lesser trochanter has concerned several writers. We found, upon examining postoperative roentgenograms, that there were five subtrochanteric and nine intertrochanteric osteotomies. There was no relation between these findings and the functional outcome of the operation.

Since it has been customary in this clinic to use other methods, no cases are reported here of the bifurcation operation for old congenital dis-

located hips. Yet the bifurcation operation was indicated primarily for this condition and it is thus used successfully elsewhere. Our series included six cases of ununited fractured neck of the femur, two of osteo-arthritis of the hip, two of suppurative arthritis with pathological dislocation, two of the Charcot hips and two of tuberculous hips.

Painlessness

The relief from pain and instability, which the bifurcation operation affords, is its chief advantage. The patient's trouble of this nature is due to the elastic suspension of the body weight upon the soft tissues over the end of the femur. Notwithstanding the theoretical objections that have been raised, it is the experience of others, and of this clinic, that the pressure from the new supporting surface of the femur against the old capsule or the pelvic periosteum does not cause pain. Eleven of the fourteen cases reported were completely freed from pain by the operation. The other three, which were among the failures, had less pain than before operation, although it was not entirely absent.

Stability

The stability which followed the operation was so greatly improved in most cases that nine of the fourteen cases needed no support whatever. Two patients had a negative Trendelenberg sign. Crutches were still necessary for two patients with fractured hips, one with a Charcot hip, two with tuberculous hips. The two Charcot hips were the only ones that permitted telescoping postoperatively.

Mobility

While this operation does not afford the amount of mobility that is often possible in the nicer anatomical reconstructions, still a useful range of motion is usually obtainable. A flexion contracture of approximately fifteen degrees was present in most of the cases, but there were no other contractures. The operation did not increase the amount of motion over the preoperative range, but it did correct the preexisting deformities. The least motion resulted among the osteo-arthritic cases. But these patients had very little useful movement before their operation. The abnormal mobility in the two Charcot hips was a disadvantage, since the hips could telescope and could not be voluntarily controlled. The preoperative range of motion was nearly all retained in the tuberculous cases.

Shortening

A reasonable amount of shortening is to be expected following any reconstruction operation on the hip. The average shortening due to this operation in the eight fracture and osteo-arthritic cases, was one-quarter of an inch. In return for the improved alignment of the extremity, this is a negligible quantity. Because of the disintegration of the acetabulum in the two Charcot hips, and the resultant excursion and telescoping, there

FIG. 2-A

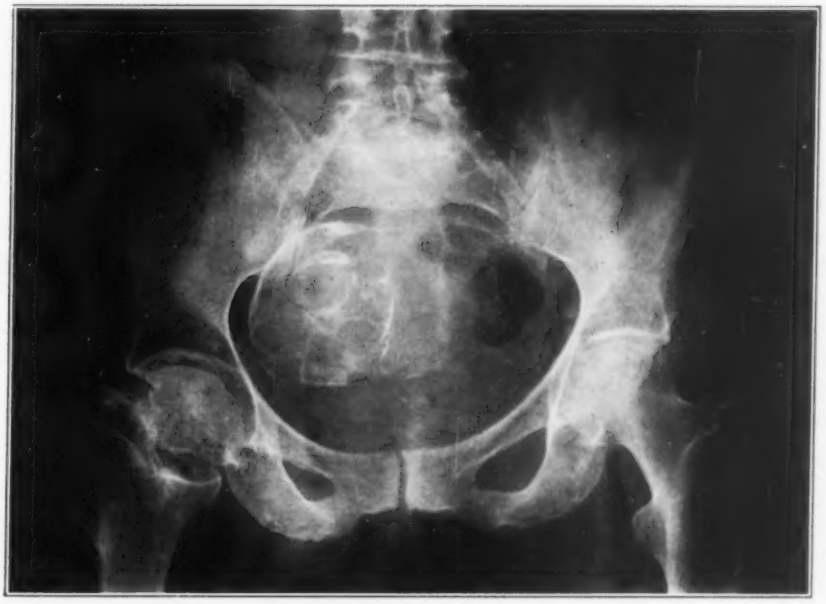

FIG. 2-B

A. W., aged sixty-seven, fracture. Bifurcation intertrochanteric, no pain, good stability, fair motion, one-half inch increased shortening. Good result.
Fig. 2-A. Before operation. Fig. 2-B. Final roentgenogram.

was shortening averaging three inches. From our inability to determine on the roentgenogram the exact point on the pelvis where the femur would find anchorage, there occurred perhaps more shortening in the cases of suppurative arthritis with pathological dislocation than otherwise would have been the case. Yet the beneficial postoperative features obviated such slight disadvantage as the increased shortening produced.

End Results

The end results of these fourteen cases may be determined on the consideration of the relief of pain, the stability, the alignment, the mobility, and the shortening that followed the operation. One must also remember the poor preoperative condition that many of these patients presented, and remember that the bifurcation operation was indicated as a last resort. Eight among the fourteen cases may be classified as having a good functional result. The bifurcation operation gave a good result in all osteo-arthritic and pathological dislocated hips. It failed in all Charcot and tuberculous hips. One patient with a fractured neck of the femur is now able to walk three miles a day without discomfort. Others follow their occupation with little impediment. Most of them notice certain little inabilities,—*e.g.*, putting on their shoes.

Analysis of Poor Results

From the type of patients considered here, it would be too much to expect any operation to be a panacea. It is, therefore, not surprising that six of the fourteen cases were failures. Careful analysis of each case may reveal the reason for failure to improve by operation. Two patients with fractured neck of the femur failed to be improved by the bifurcation operation. One of these was an obese, diabetic man of fifty-three, who had a mid-thigh amputation of the opposite extremity and an arthrodesed knee on the side of the fractured hip. Following operation, he is still confined to crutches and still has pain in his hip. The other patient, a woman of sixty-four with generalized arteriosclerosis and hypertension, was a poor surgical risk. Although she withstood the operation markedly well and without any shock, two weeks later she complained so bitterly of pain in both heels that the cast was changed. Unfortunately the fragments slipped slightly following this procedure. A year after operation she still complains of pain in her hip and heels and refuses to walk without crutches. However, careful clinical examination fails to account for her subjective findings.

The roof of the acetabulum in each of the Charcot hip cases disintegrated following the operation, and thus the supporting portion of the femur dislocated from the resulting shallow acetabulum. We had a similar experience with the Whitman reconstruction operation in this condition. It is now felt by us that all reconstructive measures are contraindicated in Charcot hips, since the motion that results is not controlled, and the stability is only temporary.

FIG. 3-A

FIG. 3-B.

S. K., aged twenty-three, suppurative arthritis with pathological dislocation, separation of symphysis pubis. Bifurcation subtrochanteric. No pain, good stability, good motion, one and one-half inches increased shortening. Good result.
FIG. 3-A. Before operation. FIG. 3-B. Final roentgenogram.

TABLE I

SUMMARY OF CASES

	Ununited Fractured Neck of Femur	*Osteo-Arthritis of Hip*	*Suppurative Arthritis with Pathological Dislocation*	*Charcot Hip*	*Tuberculous Hip*
Number of cases	6	2	2	2	2
Average age	58	59	18	35	17
Sex:					
Male	2	1		1	
Female	4	1	2	1	2

Average length of observation—27 months

TABLE II

POSTOPERATIVE FINDINGS

	Ununited Fractured Neck of Femur	*Osteo-Arthritis of Hip*	*Suppurative Arthritis with Pathological Dislocation*	*Charcot Hip*	*Tuberculous Hip*
Roentgenogram of osteotomy site:					
Subtrochanteric	1		2		2
Intertrochanteric	5	2		2	
Pain:					
None	4	2	2	1	2
Slight	2			1	
Support needed:					
None	4	2	2	1	
Crutches	2			1	2
Average range of motion:					
Flexion	55 degrees	10 degrees	35 degrees	90 degrees	60 degrees
Abduction	20 degrees	0 degrees	30 degrees	30 degrees	30 degrees
Adduction	10 degrees	0 degrees	0 degrees	35 degrees	20 degrees
Rotation	0 degrees	0 degrees	10 degrees		20 degrees
Average shortening	¼ inch	¼ inch	1½ inches and 3 inches	3 inches	No data
End Results:					
Good	4	2	2		
Failure	2			2	2

Average flexion contracture—15 degrees

Our results in quiescent tuberculous hips were sad. One such hip, with a calcified intrapelvic abscess, was bifurcated, but a sinus later developed, which has been draining for six years. In the second tuberculous hip operated upon by this method, a sinus developed, now of eighteen months' duration, and the fragments of the osteotomy also failed to unite. Although Hass gives sixty-six per cent. of good and thirty-four per cent. of

sufficient results in a much larger series of tuberculous cases, nevertheless, under our own circumstances, we must hesitate to recommend the bifurcation operation in this condition.

SUMMARY

This is a study of results of the bifurcation operation in fourteen cases. The procedure is a palliative measure which has a definite field of indications. It is a simple method, carrying little surgical danger, but requiring strict attention to details in order to obtain good results. The series here reported included patients with fractured neck of the femur, osteo-arthritis of the hip, dislocated hip, Charcot and tuberculous hips. Eight good results were obtained by this operation.

It is with sincere appreciation that the writer acknowledges the privilege of preparing this report and the guidance shown him by Dr. Steindler.

BIBLIOGRAPHY

1. Albee, F. H.: Reconstruction and Plastic Operations on the Hip. J. Am. Med. Assn., LXXXV, 1345, 1925.
2. Ashley, D. D.: The Lorenz Bifurcation Operation. New York Med. J., CVII, 136, 1923.
3. Galland, W. I.: The Bifurcation Operation. Indications, Technique and Results. Surg. Gynec. Obstet., L, 90, 1930.
4. Hass, J.: Zur Technik der Lorenzschen Bifurkation. (Die Schräg Frontale Osteotomie.) Ztschr. f. Orthop. Chir., XLIII, 481, 1924.
5. Hass, J.: Die Lorenzsche Gabelung und ihre Anwendungsgebiete. Ergebn. d. Chir. u. Orthop., XXI, 457, 1928.
6. Lorenz, A.: Ueber die Behandlung der Irreponiblen Angeborenen Hüftluxationen und der Schenkelhalspseudarthrosen mittels Gabelung (Bifurkation des oberen Femurendes). Wiener Klin. Wchnschr., XXXII, 997, 1919.
7. Lorenz, Adolph: A New Method of Treatment of Irreducible, Acquired or Congenital Hip Dislocations. New York Med. J., 117, 130, 1923.
8. Lowendorf, C. S.: Whitman Reconstruction Operation on the Hip Joint; an Analysis of Late Results. Arch. Surg., XXV, 863, 1932.
9. Reich, R. S.: The Bifurcation Operation for the Treatment of Irreducible Dislocations of the Hip Joint. J. Bone and Joint Surg., VII, 598, July 1925.
10. Speed, J. S.: Reconstruction Operation on the Hip. J. Am. Med. Assn., LXXXVII, 1631, 1926.
11. Steindler, A.: Lectures on Advanced Kineseology. (Unpublished.)

FRACTURE SEPARATION ("SLIPPING") OF THE LOWER FEMORAL EPIPHYSIS

Report of a New Procedure for Reduction

BY EDWARD P. HELLER, M.D., KANSAS CITY, MISSOURI

Attending Surgeon, Orthopaedic Department, Kansas City General Hospital

Slipping of the lower femoral epiphysis is not a very rare accident and invariably occurs before the twenty-first year. The difficulties encountered in reduction are only second in importance to the possible damage to the popliteal vessels in the original accident, or by the manipulative attempts of the surgeon.

So far as the author is able to discover there is nothing in the literature comparable to the technique employed in the case reported below. The usual method is to try horizontal extension and manipulation. Failing in this, various manoeuvers—such as that of Hutchinson and Barnard [1]—are usually tried, or traction on a double inclined plane. In a rare case open operation is done.

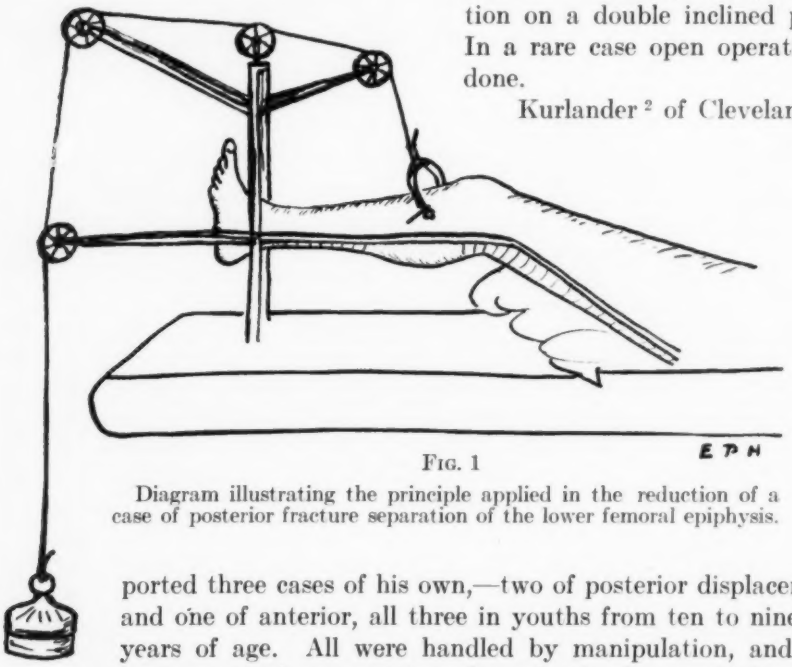

Fig. 1

Diagram illustrating the principle applied in the reduction of a case of posterior fracture separation of the lower femoral epiphysis.

Kurlander [2] of Cleveland reported three cases of his own,—two of posterior displacement and one of anterior, all three in youths from ten to nineteen years of age. All were handled by manipulation, and one later required amputation through the lower thigh, after gangrene had developed from injury to the popliteal vessels following two attempts at reduction under general anaesthesia. He called attention to the few reported cases of this fracture and to the fact that none of the standard American texts described the condition or its treatment except Scudder. Manipulation was the only treatment suggested. This

FIG. 2

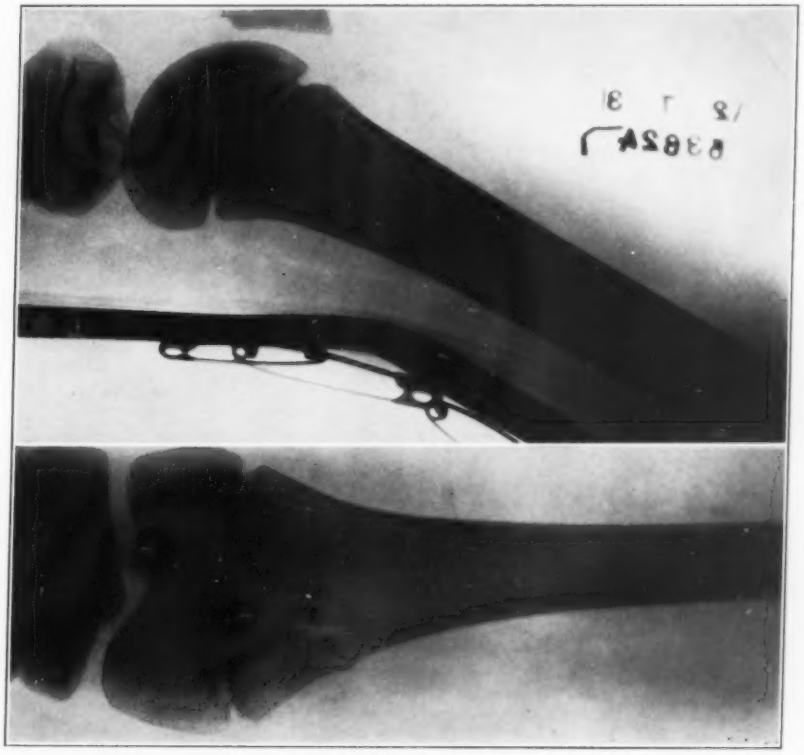

FIG. 3

is, therefore, the only case known to the author in which a skeletal traction procedure has been used.

F. K., boy aged twelve, Kansas City General Hospital No. 36532, admitted to children's ward of Kansas City General Hospital December 2, 1931. Roentgenogram showed: ". . . fracture of the lower end of the left femur entering into the epiphyseal junction. The epiphysis and medial condyle are displaced inward and backward" (See Figure 2).

The extremity was at once placed on a Böhler frame, with adhesive traction from the knee down, in the hope that traction on a two-plane principle would effect some reduction. When it became apparent that no good was being accomplished, thirty-six hours after admission, a Kirschner rustless wire was passed through the upper tibia, and the weight cord rigged as shown in the illustration. Under primary ether anaesthesia in the dressing room attached to the ward, upward pull was exerted, while a house doctor kept firm pressure on the shaft of the femur as it lay on the Böhler frame. Reduction was simple and, as shown in Figure 3, complete. The boy was allowed to remain in traction, with the splint rigged as shown, for a period of twelve days, when it was deemed safe to remove him from the traction apparatus, apply a cast, and send him home.

At no time was the boy in any discomfort as a result of the Kirschner pin or the attached traction. The system used was not calculated to endanger the popliteal structures in any way, and is in marked contrast to the manipulative method reported by authors up to the present time.

REFERENCES

1. Hutchinson, J., Jr., and Barnard, H. L.: A New Method of Reduction in Separation of the Lower Epiphysis of the Femur. Lancet, I, 1275, 1899.
2. Kurlander, J. J.: Slipping of the Lower Femoral Epiphysis. J. Am. Med. Assn., XCVI, 513, 1931.

SLIPPING OF THE UPPER FEMORAL EPIPHYSIS *

Treatment in the Pre-Slipping Stage

BY S. A. JAHSS, M.D., NEW YORK, N. Y.

Although many forms of treatment for this condition in the pre-slipping stage have been tried, the end results have not been consistently good. These treatments have consisted of rest in bed, with or without traction, plaster spicas, braces, and, finally, drilling of the epiphyseal plate with the introduction of bone slivers. The last procedure cannot be considered a conservative measure.

The time element and the possibility of further slipping are the two most important objections to these procedures. As long as the head remains loosely attached to the neck, it may become displaced. Why this takes place is still unknown, but the fact remains that such is the case.

It is a known fact that all cases of slipping epiphyses heal eventually. This can only be explained by assuming that the continued trauma of slipping causes a premature ossification of the epiphyseal plates of the head and neck. This reason may seem far-fetched, but it has been seen in cases of injury to the epiphyses of the lower end of the humerus with the resultant deformity of either cubitus varus or cubitus valgus.

The idea of supplying trauma then presented itself and the following method was evolved.

Traumatization of the Epiphyseal Line

With the patient fully anaesthetized, the limb is brought into a position of full extension, slight *internal rotation* and about ten degrees of *adduction*. In this position the greater trochanter is most prominent. A piece of thick, heavy felt is placed over the greater trochanter and part of the shaft. Two strips of adhesive plaster hold it in position. An assistant stands on the opposite side of the patient and exerts counter-pressure on the pelvis and thigh of the normal side. By means of the Cotton hammer, four or five rather vigorous blows are struck. The direction of the force is in the line of the neck. The trochanter receives the brunt of the trauma, which is transmitted through the neck to the epiphyseal line. The limb is then immobilized in a long plaster spica in a position of about 170 degrees, full abduction, and slight internal rotation

After-Treatment

After one week the patient is allowed to walk with the aid of crutches. The shoe on the normal side is raised. After three months the plaster is bivalved and active treatment, consisting of diathermy, massage, and

* From the service of Dr. Herman C. Frauenthal.

FIG. 1

Fragmentation and marked absorption of the neck for a depth of one-half inch. Marked widening of the epiphyseal line.

FIG. 2

The fragmentation has disappeared. There is a normal epiphyseal line with ossification at its central portion.

active motion is instituted, if there is occasion for it. In the three cases here reported, two needed no treatment, whereas the third required only two weeks of treatment. Further protection of the hip is not entirely necessary at this time. As a measure of caution, the patient may be asked to wear a Thomas walking caliper brace for a short time.

CASE REPORTS

CASE 1. C. M., male, twelve and one-half years of age. Child began to limp about the middle of July, 1931; at that time, there was no pain associated with the limp. The child, however, tried to favor that extremity. This limp lasted only one day, after which he again walked normally. He was then sent to camp for three weeks. During the last week at camp, he again developed a painless limp for one day. After returning to the city, he limped for three days (third week in August). In September, this happened again. These attacks of limping had followed violent exercise, and had always been transitory.

Physical examination revealed a thin, well developed youngster, not acutely ill. He walked with a limp, body being tilted about fifteen degrees to the left every time weight was borne on the left lower extremity. Motion at the left hip was practically normal in range; there was a slight restriction of internal rotation. He was admitted to the Hospital for Joint Diseases on September 18, 1931.

Roentgenographic examination on admission (Fig. 1) showed a widening of the epiphyseal line and fragmentation of the epiphyseal end of the diaphysis. There were irregular areas of absorption for a distance of one-half inch distal to the epiphysis; no slipping of the epiphysis proper.

Operation on September 28, 1931. Readmitted on January 7, 1932.

Roentgenographic examination (Fig. 2) at this time revealed *no* fragmentation, a rapid filling in of the areas of absorption, the appearance of a normal epiphyseal line with ossification at its central portion.

Physical examination a few days later revealed a normal range of motion at the hip.

CASE 2. J. L., male, fourteen and one-half years of age. Chief complaint, limp; duration, three months. About four months ago, while standing on a bed spring, patient's left leg slipped through an opening in the spring. He fell but apparently did not injure himself. Three months ago he began to limp but had no constant pain. On arising from a sitting position, patient experienced pain in his left hip, but this pain gradually diminished and finally would disappear after walking a short distance. The limp, however, persisted, but had not become more pronounced since its onset three months before. He was admitted to the Hospital for Joint Diseases on October 2, 1931.

Physical examination revealed an obese boy, white, "Fröhlich" type, not acutely ill. Weight, 157¾ pounds. He walked with a limp, body tilting fifteen degrees to the left. Angle of greatest extension 180 degrees, angle of greatest flexion 70 degrees. Abduction 35 degrees, adduction 15 degrees, external rotation 45 degrees, internal rotation 0. Limbs were equal in length.

Roentgenographic examination (Fig. 3): Absorption of the neck distal to the epiphyseal line, more marked in its lateral portion. No slipping of the epiphysis.

Operation on October 5, 1931. Readmitted on January 7, 1932.

Roentgenographic examination (Fig. 4) at this time showed complete union between the head and neck of the femur; no area of absorption.

On January 30, 1932, patient slipped and fell, sustaining a traumatic synovitis of the left knee. Motion at the hip remained unimpaired and there was no pain in the hip. At this time full motion at the hip was present.

Having had such gratifying results with these very early cases, it was decided to apply the same form of treatment when a case with mild slipping presented itself. Inasmuch as the shortening was about one-half of one inch and the range of motion fairly

FIG. 3

Note the absorption, particularly in the lateral portion of the neck, just distal to the epiphyseal line.

FIG. 4

Shows complete ossification of the epiphyseal line.

FIG. 5

Note the pronounced absorption of the neck just distal to the epiphyseal line.

FIG. 6

Entire absence of absorption with complete union of the epiphysis to the neck.

good, it was thought that it would be best to obtain union with the slight slipping, rather than to attempt to break up the insecure union of the head to the neck and then manipulate it to obtain perfect anatomical replacement.

CASE 3. D. K., female, ten years of age, white. Chief complaint, limp.

History: Five months prior to admission to the hospital, she slipped, while skating, striking her right hip against the pavement. Three days later she complained of pain in the hip, which gradually subsided in about three days. One week later the pain returned for a period of three days and then subsided completely. One month ago the child began to limp but had no pain except when she took the first few steps or after sitting for a considerable length of time. She also complained of a tired feeling in the hip after walking short distances. She was admitted to the Hospital for Joint Diseases February 5, 1932.

Physical examination revealed an obese female of the "Fröhlich" type. As the child walked, there was a tilt of the body to the right of twenty-five degrees. The Trendelenberg sign was positive on the right. The right lower extremity was held in a position of twenty-five degrees of external rotation. From this point it was possible to internally rotate the limb fifteen degrees. Therefore, there was a ten degrees' external rotation deformity present. Internal rotation was 0; external rotation, normal. Angle of greatest flexion 70 degrees, angle of greatest extension 180 degrees. Abduction 35 degrees; adduction 20 degrees. Length of the left lower extremity was thirty and three-quarters inches; length of the right lower extremity, thirty and one-quarter inches.

Roentgenographic examination (Fig. 5) at this time showed a slight lateral displacement of the neck, condensation of the epiphyseal line (the result of posterior rotation of the head, causing an overlapping of the head on the neck), absorption of the neck just distal to the epiphyseal line, more pronounced at its medial aspect.

Operation February 8, 1932. Readmitted to the hospital April 26, 1932.

Roentgenographic examination (Fig. 6) at this time showed the complete absence of these areas of absorption with union of the head to the neck.

Physical examination on May 3, 1932, revealed a complete return of the normal range of motion at the hip.

SUMMARY AND CONCLUSION

By traumatizing the epiphyseal line, it is possible to obtain premature ossification in the pre-slipping and mildly slipping cases of adolescent coxa vara, as the splendid results in the three cases reported have shown. The Cotton mallet is used for this purpose.

CLINICAL AND EXPERIMENTAL OBSERVATIONS WITH REGARD TO THE INJECTION OF CERTAIN AGENTS (PREGL'S SOLUTION) INTO CHRONIC ARTHRITIC JOINTS *

BY J. E. M. THOMSON, M.D., LINCOLN, NEBRASKA

Chronic arthritis with persistent effusion and thickening of the capsule, whether due to infection or injury, or both, often defies the ordinary methods of treatment and proves disabling. Frequently, patients come with the story of painful swelling of the knee which has been constant for months, perhaps starting with an attack of rheumatism, a fall, or a sprain. The joint has become progressively larger, stiffer, and more disabling.

Certain of these conditions which are due to mechanical derangement of the knee cartilage, ligaments, etc., must be treated surgically for the correction of the derangement; even these cases often present a convalescence associated with chronic swelling of the joint. A small group of chronic infectious arthritis patients are benefited by synovectomy. It is difficult, however, to determine what cases are suitable for this treatment; but, if it could be accurately determined at what stage in the progress of an infectious arthritis the operation is indicated, the results would be gratifying. The operation has a definite field of usefulness, but, as Swett and others have indicated, it is not a panacea.

The results of injections have been uncertain. Occasionally there has been a decided shrinking in the size of the swelling and diminution of the secretion within the knee with relief of these symptoms, particularly when accompanied by accurate treatment of the arthritic process.

Subsequent observations seem to justify the opinion that there is a mechanical or chemical reaction caused by the pathological phenomena of increased synovial secretion that has a retarding effect on the healing process of the arthritic joint. Furthermore, if some substance could be brought in contact with the synovia that would tend to diminish its secretion and shrink the tissue substance within the joint, there would be relief of the symptoms of distention, and of the mechanical irritation of the pathological synovial formations; and, by producing a more normal joint relationship of tissues, a better opportunity would be afforded by immunization, medication, physiotherapy, etc., to render an effective result.

My attention has been directed to Pregl's solution with which, in the clinics of Vienna, rather striking results have been obtained in the treatment of empyema, meningitis, and gonorrhoeal arthritis. This solution appeared first as a secret preparation, described by Pregl in 1919 as a non-irritating, non-staining, watery solution of free and combined iodin with certain iodides. He advocated its use in infections of all kinds, and it has been used by a large number of observers.

* Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, Canada, June 16, 1932.

A résumé of the recent observations in regard to the therapeutic value of Pregl's solution convinced me that its introduction into the joints would at least do no harm; furthermore, that the antiseptic properties and the astringent qualities exhibited by this iodin solution might prove valuable in treating chronic synovial effusions associated with chronic arthritis.

I had as a patient a doctor who, following an injury on the golf course, sustained a disabling swelling of an old arthritic knee joint. This condition had persisted for several weeks. He was willing to try anything; so with great temerity I drew out some clear, straw-colored fluid from the knee and injected five cubic centimeters of Pregl's solution. The result was indeed commendable. Within twenty-four hours he was better and the effusion remained markedly diminished. After three injections, five to seven days apart, the effusion had entirely disappeared and he started east on a trip. To date he has had no return of his former condition.

With this initial experience, a second case was tried with an equally gratifying result. The effusion seemed to melt away; or, at least, with each injection less effusion resulted, until finally practically normal contour was established in the joint. Unfortunately, no photographs have as yet been taken of any of our patients before or after treatment. Case histories themselves must tell the story. The formula used in the method of preparation of the solution which I use is as follows:*

To a solution of crystallized sodium carbonate sixteen grams to thirty grams of water, add three grams of finely powdered iodin and allow it to stand for twenty-four hours, rotating frequently, or warm to forty degrees, centigrade, on a water bath. When all the iodin is in solution, add four grams of sodium chlorid and water to make one liter.

Bring this to .035–.04 per cent. iodin by gently warming the solution, or part of it, until twenty cubic centimeters is decolorized by .55–.65 cubic centimeters of tenth normal sodium thiosulphate; or until the tint is the same, in equal liquid depth, as that obtained by a mixture of ten drops of tenth normal iodin and fifteen cubic centimeters of water.

The Pregl's solution may be injected into the knee joint, with the patient in the prone or the sitting position. When possible, it is preferable to have the patient sitting with the affected thigh flexed on the abdomen, and the patient's hands clasping the flexed leg on the thigh. This position separates the joint surfaces and places the effusion under considerable tension, thereby making it much easier to remove. It is not at all difficult to insert the aspirating needle into the joint from a point one-half inch internal to the lower patellar tendon, and half an inch above the articulating margin of the tibia. After painting a small area with iodin, two cubic centimeters of one per cent. novocain are used to infiltrate the tissues down to and through the capsules; the aspirating needle is then inserted into the joint with little discomfort and the effusion withdrawn. No effort is made to remove all the synovial fluid. Into a small syringe are drawn five or ten cubic centimeters of Pregl's solution warmed to body temperature. This is injected into the joint, the needle removed, a small dressing applied, and the patient allowed to go about his business as usual.

* The method described is that which appeared in the Journal of the American Medical Association, LXXXI, 1628, 1923.

TABLE I

Summary of Cases Treated with Pregl's Solution

No.	*Sex*	*Age*	*Occupation*	*Part Injured*	*History*	*Previous Treatment*	*Fluid Withdrawn*	*Amount of Pregl's*	*No.*	*Result*
Dr.C. 0237	M.	40	M.D.	Right knee	Old arthritis, injured by fall and twist, effusion, persistent for four weeks.	Aspiration, hot packs—temporary relief	18 c.c.	5 c.c.	4	Recovered
M.H. 0267	F.	30	Dietitian	Right knee	Injury to old arthritic knee, tear of internal semilunar cartilage; chronic synovitis; effusion.	Operation, physiotherapy, vaccines	5 to 30 c.c. clear	5 to 7 c.c.	16	No effusion or acute condition
C. N. 0297	M.	30	Lineman	Right knee	Chronic arthritis of long standing. Injury to internal semilunar cartilage. Arthritic changes discovered at operation.	Operation, physiotherapy, rest	Bloody fluid			
					Second operation after Pregl's showed no evidence of previous arthritic condition.		Profuse, not measured	5 c.c.	5	Effusion destroyed; arthritis relieved
E. N. 01320	M.	27	Mechanic	Left knee	Extensive osteo-arthritis and synovitis. Previous operation and cast five years ago. Recent injury to crucial and external semilunar destruction of cartilage apparent at operation.	Operation, brace, physiotherapy, vaccines	15 c.c., of bloody fluid	5 to 7 c.c.	6	No effusion; arthritis arrested
D. H. Orth.	M.	26	Mechanic	Right knee	Internal semilunar injury and operation. Two months later, external cartilage injury. Destructive arthritic changes discovered at second operation. Wound filled with Pregl's solution.	Tried to work after first operation but could not	Bloody fluid, first two aspirations	7 c.c.	4	Recovered
B. 01689	M.	33	Farmer	Left knee	Injury four weeks prior to examination. X-ray negative. Persistent swelling and stiffness, pain.	Packs, rest	Clear fluid	5 c.c.	2	Complete recovery
H. C. C.	M.	29	Laborer	Left knee	Injury five weeks ago. Swelling and stiffness; completely disabled. X-ray negative. Arthritic history.	Iodides, packs, rest, vaccines	10 c.c., clear	5 c.c.	2	Recovered
L. C. C.	F.	56	H.W.	Right knee	Swelling and pain for two weeks, flare-up of old arthritis of knee.	Vaccines	Clear, straw	5 c.c.	2	Recovered
D. E. C. C.	F.	14	Child	Both knees	Effusion of both knees for two months, worse on right. No pain; some stiffness. All tests negative.	Vaccines	20 c.c., clear fluid, right	8 c.c.	5	Very much improved
K. 01787	F.	53	H.W.	Right knee	Chronic arthritis with effusion.	Vaccines	10 c.c., clear	5 c.c.	2	Recovered
F. 01788	M.	49	Mechanic	Right ankle	Acute pain and swelling following accident, few days previous. Fluctuation, redness. Temp. 101; W.B.C. 14500.		7 c.c., purulent	5 c.c.	1	Recovered
L. B. C. C.	M.	35	Laborer	Bursitis of elbow	Olecranon bursa—two weeks.		3 c.c., clear	3 c.c.	1	Recovered
G. G. C. C.	M.	20	Student	Left ankle	Gonorrhoeal arthritis of ankle—three weeks.	Vaccines	Purulent fluid	5 c.c.	1	Improved
Mrs. B.	F.	58	H.W.	Prepatellar bursitis	Bursitis from scrubbing.		Bloody	4 c.c.	1	Improved

No reaction has been noted either of a general or local type. Sometimes a patient will complain of pain and discomfort for the first few hours; after that considerable relief is expressed uniformly. In five to seven days this procedure is repeated, and usually two to five injections are sufficient to stop the effusion and relieve the symptoms.

Thirteen cases are summarized in the table. The synovial fluid withdrawn in each instance was cultured, and no growth occurred in a single instance. The following brief survey of two cases is illustrative of the uniform results obtained in the series summarized. The first case is one in which arthritis is complicated by injury; the second is of undetermined etiology.

CASE 1. (No. 0267.) Miss H., female, aged thirty, dietitian by occupation, had had an old arthritis in the right knee for many years. She slipped on the dance floor of the club in which she was employed, severely injuring the knee. She had all the symptoms of injury to the internal semilunar cartilage. On June 16, 1931, operation was performed. The cartilage was removed and was of the "bucket-handle" type. There was a destructive change in the cartilage surface of the condyles, and a generalized synovial pannus. Exploration of the outer side of the knee showed no evidence of injury to the external cartilage, but a similar arthritic process existed. She had an uneventful convalescence from the operation, and the wound healed by first intention. She continued to have swelling and profound disability and inability to use the knee. After four and a half months of physiotherapy and treatment of the arthritis, on October 3, 1931, twenty cubic centimeters of clear, straw-colored fluid were withdrawn from the knee, and five cubic centimeters of Pregl's solution were injected. Injections were continued at irregular intervals until April 18, 1932, there being sixteen injections in all. We were unable to

FIG. 1

Rabbit No. L. Knee Joint No. 21 treated with Pregl's solution shows much less hypertrophy of the synovia and pannus than the untreated Knee Joint No. 29. There was considerable erosion of the cartilage in Knee Joint No. 29, whereas cartilage of No. 21 was smooth.

FIG. 2

Rabbit No. N. Note the marked difference in the synovia and cartilage edges between Knee Joint No. 9, which was treated with Pregl's solution, and Knee Joint No. 3, in which no treatment was administered. No. 3 was extremely red, thickened, with extension of synovia over the femur with adhesions on the inner aspect, frayed margins, and destruction of the cartilage along the edges of the condyle as well as of the patella; while No. 9 had a clean, bright, normal-appearing synovia and the cartilage injury was apparently healing.

withdraw any fluid at the occasion of the seventh injection. Function of the knee is very markedly improved, and she has a range of motion to eighty per cent. The knee is still quite thickened, but, as the knee has been enlarged for two or three years, it is a little difficult to tell how much shrinkage will result. Two months after the operation she resumed her duties, although she wore a brace until about four months ago. The effusion has entirely disappeared; she is much improved, and has no pain or discomfort in the knee. This has been by far the most serious case I have treated, and one which showed absolutely no progress until injections of Pregl's solution were started. She has received no treatment since the first part of April. Prior to that time she had come in occasionally and desired another injection of Pregl's solution as it seemed to give a certain amount of relief of discomfort in the knee. In this case, under ordinary circumstances, I would have performed a synovectomy, but she would not consent to an operative procedure.

CASE 2. Dorothy E. (City Clinic), female, aged fourteen. For six months she had had persistent swelling in both knees, the right more severe than the left. She was left with some stiffness and swelling together with pain. All tests for tuberculosis, syphilis, and gonococcus were negative. Cultures from the effusion were negative. She was under observation for three or four months. About six weeks ago twenty-four cubic centimeters of clear, straw-colored fluid were drawn from the right knee and seven cubic centimeters of Pregl's solution were injected. After five injections the right knee had assumed nearly normal appearance and the swelling of the left knee had remained constant. Crowe's stock vaccine was given during this period, rather empirically. Two weeks ago the left knee was aspirated and injected with Pregl's solution, and improvement was evident at the time of the second injection. Although one of our more recent cases, she has proved most interesting in that a similar condition existed in both knees with a chronic effusion that had lasted over six months. An accurate diagnosis has not been made; but, until this treatment was instituted, the condition had become progressively worse. The right knee, which was the more severely affected, was treated for five weeks with the result that it had assumed almost normal appearance, while the left knee

remained constant. Now the Pregl's solution has been injected into the left knee, with the result that the effusion has disappeared. Both knees have assumed normal contour and appearance, and the patient now has no discomfort or disability.

The clinical manifestation of the value of Pregl's solution in the first few cases of chronic synovitis, or effusion associated with trauma and arthritis, led me to attempt an experimental study to determine the effect of the solution on the joints of rabbits affected with similar pathological conditions. This work was started in November 1931, and carried out in the experimental laboratory of the Lincoln General Hospital with the assistance of Dr. Fritz Teal, and Miss Mildred Wieland. We endeavored to follow the methods of stimulating arthritis and synovitis developed by Key and others. Our space was limited and few animals could be worked with at a time; therefore, we have not progressed very far with this problem. To date sixteen rabbits have been used, but, in order to carry out the project accurately, only four were brought to a sufficient culmination to allow a report of the results obtained.

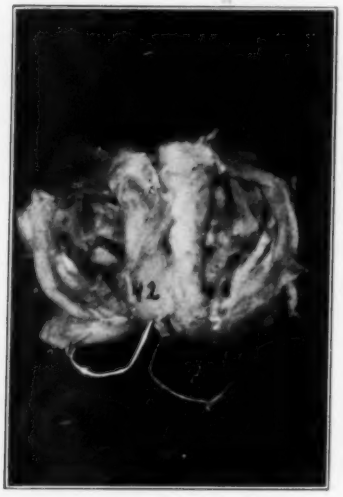

FIG. 3

Rabbit No. P. Knee Joint No. 42 was treated with Pregl's solution, four injections, while Knee Joint No. 48 was untreated. Cartilage of both joints was extensively destroyed before treatment was started. Knee Joint No. 42 into which the Pregl's solution was injected showed grossly marked healing of the diseased synovia; however there was but little healing of the cartilage; while the synovia of knee Joint No. 48, which was untreated, was very much thickened, red, and infected, and was filled with a purulent exudate.

Arthritis was produced by two methods, first, by introducing infection into the joint directly; second, by introduction of one-half of a cubic centimeter of one per cent. carbolic solution and one-half strength tincture of iodin. In most instances a period of two to four weeks elapsed between the operative intervention and the beginning of treatment. All operations were carried out under strictly aseptic conditions. On account of the fact that we wanted exactly similar conditions in both knee joints of the same rabbit, an exploratory arthrotomy was performed before treatment was instituted, in order to determine whether the condition of both joints was similar. Then one joint was treated with Pregl's solution and the other allowed to heal without treatment. So far only gross specimens have been studied.

In adult rabbit No. L., streptococcus was introduced into both knee joints. Two weeks later the arthrotomy was performed and there was found a profound pannus and increase in synovia with changes about the joint surfaces of the condyles. Both knees appeared relatively the same. The rear extremities of the rabbit were numbered 21 and 29. The knee joint of No. 21 was injected with one and one-half cubic centimeters of Pregl's solution three days following the arthrotomy. Every three or four days thereafter a similar amount of Pregl's

solution was introduced. At the end of four weeks the rabbit developed a respiratory infection and was sacrificed. There was marked synovial change and the knee joint cartilages of both looked slightly eroded. However, knee joint No. 21 (treated with Pregl's) showed much less hypertrophy and pannus of the synovia; the joint had margins which looked almost normal, but there was some cartilage erosion of the condyles similar to No. 29.

No. N., a young rabbit fourteen weeks old, had an arthrotomy in which extremity No. 3 had the synovia scraped and injured about the margins of the joint. In the knee of extremity No. 9 a section was taken out of the external condyle and the synovial edges about the joint were scraped. Two weeks later arthrotomy was again performed. Both joints seemed extremely red, swollen, and inflamed. Profound pannus existed throughout the joints with marked increase of synovial fluid. The knee joint of No. 9 was treated with Pregl's solution every three to five days for three weeks. The rabbit was then sacrificed. There was quite evident difference between the synovia of the treated and untreated joints. The knee joint of No. 3, showed a redness, thickening, and extension of synovia over the femur with adhesions about the inner aspect of the knee. However, the knee joint of No. 9 had a smooth, clean synovia similar to a normal rabbit's knee joint. The cartilage appeared to be healing, but with considerable thickening at the border.

FIG. 4

Rabbit No. K. Knee Joint No. 60, after treatment with Pregl's solution appeared practically normal, while Knee Joint No. 62, which was untreated, showed considerable loss of cartilage and synovial thickening.

Rabbit No. P. was a young rabbit fourteen weeks old. Both knee joints were injected with a culture of staphylococcus albus. Two weeks after injection was administered, both joints were extremely swollen and fluctuating. Effort was made to remove the effusion by needle, but the material could not be withdrawn. Exploratory arthrotomy was performed in this instance and the thick seropurulent fluid withdrawn. Knee joint of No. 42 was treated with Pregl's solution every three to five days, while the knee joint of No. 48 was untreated. Thereafter the rabbit developed a generalized infection, and died three weeks after treatment was started. Although the cartilage of the femoral articulation of both joints was largely destroyed, there was considerable pannus thickening of the synovia about the margins of the knee joint of No. 48. The synovia of the knee joint of No. 42 was in no wise thickened, although it did give evidence of an extensive diseased process.

Rabbit No. K. had an arthrotomy of both knees with injury to the external condyle. The knees were washed with ten per cent. carbolic acid and iodin. However, the knee of extremity No. 60 was washed and filled with Pregl's solution prior to closing the wound. No. 62 was simply closed after the carbolic and iodin had been applied in the joint. Immediate treatment was started on extremity No. 60 and was continued at intervals of from three to five days for six weeks. The result was quite striking. The knee into which the Pregl's solution was injected after the injury and chemical trauma was practically normal, but the knee which was not treated showed extensive loss of cartilage.

Admittedly there are several sources of error in such experimental work. Microscopic sections have not been run in any of these joints.

Nevertheless, there seems to be something in the use of Pregl's solution that quite definitely affects the synovia, even in the presence of severe infection, to the extent that it apparently produces an inactivity or diminution of synovial secretion with an atrophy or shrinking of the synovia, very definitely inhibiting an infectious process and perhaps promoting cartilage regeneration. Of course this experimental data is in no wise conclusive, and the clinical material represents but a small group of cases; nevertheless, the similarity in results between the clinical cases and the experimental animals seems to warrant further investigation and a more general use of Pregl's solution in treating chronic effusion of arthritic and traumatized joints.

BIBLIOGRAPHY

Apfel, H.: Pneumococcic Meningitis. Treated with Pregl's Solution: Recovery. Report of a Case. Arch. Pediat., XLVI, 516, 1929.

Bick, E. M.: Surgical Pathology of Synovial Tissue. J. Bone and Joint Surg., XII, 33, Jan. 1930.

Cajori, F. A., Crouter, C. Y., and Pemberton, R.: The Physiology of Synovial Fluid. Arch. Int. Med., XXXVII, 92, 1926.

Cowan, A.: Subconjunctival Injection of Pregl's Solution in Gonorrheal Ophthalmia. Arch. Ophth., III, 325, 1930.

Crawford, A. S.: Intracarotid Treatment of Meningitis and Experiments with Pregl's Iodine. Trans. Assn. Resid. and ex-Resid. Physicians, Mayo Clinic (1929), X, 129, 1930.

The Intracarotid Treatment of Meningitis. Experiences with Pregl's Solution of Iodine: A Further Report. J. Am. Med. Assn., XCVIII, 1531, 1932.

Heyman, C. H.: Synovectomy of the Knee Joint. Surg. Gynec. Obstet., XLVI, 127, 1928.

Key, J. A.: The Reformation of Synovial Membrane in the Knees of Rabbits after Synovectomy. J. Bone and Joint Surg., VII, 793, Oct. 1925.

Experimental Arthritis: The Changes in Joints Produced by Creating Defects in the Articular Cartilage. J. Bone and Joint Surg., XIII, 725, Oct. 1931.

Cytology of Synovial Fluid of Normal Joints. Anat. Rec., XL, 193, 1928.

Kolmer, J. A.: Pneumococcus and Streptococcus Meningitis. Chemotherapy and Serum Therapy, with Especial Reference to Newer Methods. J. Am. Med. Assn., XCII, 874, 1929.

Langendorf, F. J.: Die Presojod-Augensalbe in der Augenheilkunde. Ztschr. Augenh., LXIX, 240, 1929.

MacKenzie, A. V.: Pregl's Solution in Treatment of Organized Exudate in Tissue of the Eye. Atlantic Med. J., XXX, 432, 1927.

Stellwagen, T. C., and McCahey, J. F.: Gonorrheal Arthritis in Adult Male; Correlation of Clinical and Urological Findings; Treatment by Injection of Seminal Vesicles. J. Urol., XVIII, 1, 1927.

Stellwagen, T. C.: Gonorrheal Arthritis; Preliminary Report of New Treatment. J. Urol., XIV, 661, 1925.

Swett, P. P.: The Present Status of Synovectomy. Am. J. Surg., VI, 807, 1929.

METASTATIC INFECTION OF BONE AND JOINTS AS THE INITIAL CLINICAL MANIFESTATION OF GASTRIC NEOPLASMS *

BY HARRY A. SINGER, M.D., AND L. WILLARD SHABAT, M.D., CHICAGO, ILLINOIS

When the source of a suppurative process in a bone or joint is sought, a lesion of the gastro-intestinal tract is seldom if ever included in the list of possibilities. Particularly is this the case if symptoms referable to the digestive system are lacking. That the primary focus of a bone or joint infection may be located in the stomach, for instance, is borne out by our experience with three patients. The first, seen clinically by one of us (H. A. S.), suffered from a suppurative osteo-arthritis of the knee. The primary site was not suspected or discovered until autopsy, when an ulcerating, infected leiomyoma of the stomach was disclosed. This case has been reported in detail, chiefly from the anatomical standpoint, by Wells.[1] Each of the two other patients entered the Hospital on account of a suppurative osteomyelitis. In each an ulcerated, infected, gastric carcinoma was found and no other source to explain the metastatic purulent process.

Because of the clinical significance of this group of cases, the individual examples appear to warrant more than mere mention. The details in connection with the case of leiomyoma are recorded elsewhere by Wells.[1] The essentials relative to the two cases of carcinoma are as follows:

CASE 1. G. H., a white man of fifty-four, entered the Cook County Hospital on June 10, 1929, complaining of "rheumatic" pains. His case was diagnosed as a subacute polyarthritis of the rheumatic type and he was given salicylates for a few days and then discharged. On October 23, 1929, he reentered the Hospital, complaining of irregular chills, fever, and profuse sweats which he had noted for a month. Although he suffered a recurrence of his joint pains shortly after his discharge in June, he experienced no severe pain until a few days prior to his present admission, when his back and right shoulder became quite painful. The patient was a sailor by occupation and had been in the tropics several times. He recalled an illness at the age of thirty-two which was diagnosed as malaria. Malarial parasites, however, were not demonstrable in the blood; and quinin failed to exercise any salutary effect.

A suppurative process was assumed, but a search for the location of the pus proved futile. X-ray examination of the joints and of the dorsal spine made shortly after admission was reported negative. A liver abscess was suspected, but neither an etiology nor physical evidence of such a lesion could be established. The patient slowly sank and died December 10, 1929. The autopsy, which was performed by Dr. R. H. Jaffé, disclosed an osteomyelitis involving the fourth and fifth lumbar vertebrae and bilateral psoas abscesses. On the greater curvature of the stomach, in the mid-portion, was a large, fungating, ulcerating, medullary carcinoma which was presumed to be the source of the bone infection. No tumor metastases were found. A relatively recent abscess in the left lower pulmonary lobe which led to an empyema had precipitated the termination.

* From the Department of Medicine, University of Illinois College of Medicine and the Cook County Hospital.

CASE 2*. J. W., a white man of fifty-two, entered the Cook County Hospital for the first time on March 14, 1929, with complaints ascribed to a suspected gastrojejunal ulcer. This diagnosis was based on the presence of what were interpreted to be ulcer symptoms and also on the history of a pylorectomy, with a posterior gastro-enterostomy, performed in 1918. He was placed on Sippy management for ulcer and appeared to improve satisfactorily. He was discharged on April 1, 1929, and immediately returned to his usual occupation.

The patient continued to work until October 5, 1929, when, while stooping, he experienced a sudden pain in the lower dorsal region which prevented him from straightening. Since the pain maintained its severity, on October 7, two days following the onset of the illness, the patient reentered the Hospital. Roentgenograms of the lower thoracic and dorsal spines taken at the time of admission were reported negative. The temperature varied between 100 and 102 degrees. Within a relatively short period a fluctuant swelling could be detected in the upper lumbar region. Aspiration with the aid of a needle and syringe yielded pus. X-ray examination at this time disclosed a destructive process involving the twelfth dorsal and first lumbar vertebrae, diagnosed as osteomyelitis. The abscess overlying the bone was incised and drained, after which decided improvement followed. Ten days after operation the temperature had returned to normal and no noteworthy pain was felt in the back.

After recovering from the osteomyelitis the patient made reference to mild gastro-intestinal symptoms. On investigation an egg-sized mass was palpated, and in the roentgenogram a filling defect in the region of the gastrojejunal stoma, interpreted as carcinoma, was disclosed. Because of the patient's refusal to submit, operation on the stomach was delayed until February 6, 1930. At laparotomy undertaken at this time, a polypoid mass encircling the gastrojejunal stoma was found and resected. There were no metastatic deposits encountered. The patient died two days after operation from a gastric hemorrhage. Permission for autopsy was refused.

The surgical specimen showed the tumor to be made up of numerous polypoid growths which projected like villi from the gastrojejunal margin into the lumen. Many of the polyps were covered with fibrin, but gross evidence of suppuration was not observed. In studying the microscopic sections, however, a dense polymorphonuclear infiltration was found in many areas, scattered among which were numerous micro-organisms. The infection of the growth was assumed to be the origin of the metastatic, suppurative spondylitis. The histological diagnosis of the tumor was adenocarcinoma.

SUMMARY AND COMMENT

We have observed three instances in which suppurative lesions of bone and joints had their origin in silent or relatively silent gastric neoplasms. In one, reported by Wells,[1] purulent arthritis of the knee was traced to an infected leiomyoma of the stomach. In a second patient, the only symptoms present during life were referable to an osteomyelitis of the spine. The primary focus discovered at autopsy was an ulcerated gastric carcinoma. The third patient entered the Hospital also on account of a purulent spondylitis. The infected carcinoma which constituted the source of the bone involvement had not caused sufficient discomfort to lead the patient to seek medical advice prior to the onset of the septic complication.

The observation that a metastatic lesion of a bone or joint may be the initial manifestation of a gastric tumor is of more than theoretical interest. From the practical standpoint it is of significance to know that, in a pa-

* For a detailed report of this case from the gastro-intestinal standpoint, see Singer [2].

tient of cancer age, an osteomyelitis or suppurative arthritis of obscure origin may be due to an ulcerating growth in the digestive tract. Since the stomach is the most common site of primary carcinoma, a search for a gastric malignancy is warranted under these circumstances.

It is, furthermore, important from the practical side to note that carcinomata which are prone to lead to metastatic infection are generally fungating and polypoid. This type of tumor tends to grow into the gastric lumen rather than along or beyond the walls, a circumstance which permits extirpation and favors permanent cure. In all three cases referred to, a knowledge on the part of the attending physicians and surgeons of the factors involved would have rendered the ultimate outlook more hopeful.

BIBLIOGRAPHY

1. Wells, H. G.: A Case of Leiomyoma of the Stomach with Fatal Termination. Trans. Chicago Path. Soc., XII, 5, 1924.
2. Singer, H. A.: Carcinoma of the Gastrojejunal Stoma Following Operation for Peptic Ulcer. Arch. Int. Med., XLIX, 429, 1932.

A CASE OF PROGRESSIVE ATROPHY OF THE FACIAL BONES WITH COMPLETE ATROPHY OF THE MANDIBLE

BY K. H. THOMA, D.M.D., BOSTON, MASSACHUSETTS

Professor of Oral Pathology, Harvard Dental School
Oral Surgeon, Brooks Hospital, Boston

This case is reported because, as far as can be ascertained, it is the only case on record of complete atrophy of a bone, and because its etiology presents probably an unanswerable question. The case was referred to the author for study by Dr. R. H. Norton.

Only one case approaching it could be found in the literature,—that of Absorption of the Humerus after Fracture.[1] The patient fractured the humerus three times, after which the bone slowly and painlessly disappeared. The skin of the arm was never broken and no bone came out. The specimen from autopsy (patient died at age of seventy) was dissected by Prof. T. Dwight, and is now at the Warren Museum. The roentgenogram of this specimen taken by Dr. Sosman shows three thin spicules of bone, the only part of the humerus remaining.

CASE REPORT

Mrs. M. S., aged thirty-six, housewife.

Family History: There was no family history of cancer, tuberculosis, diabetes, gout, rheumatism, arthritis, kidney disease, hemophilia, anomalies in size, epilepsy, insanity, or venereal disease. The father died of heart trouble at thirty-five; there was no other history of heart trouble in the family. One sister had a goiter and was said to be nervous.

Marital History: Patient had been married sixteen years. Husband was living, as were three children; the oldest, son of fifteen, had enlarged glands in neck and hay fever; the second, boy of twelve, and third, boy of six, were well. Patient had had no miscarriages. Her teeth ached quite a little with the first baby and less with the second.

FIG. 1

Dental film taken August, 1924. No evidence of pyorrhoea or alveolar resorption.

Past History: Pertussis and measles in childhood; occasional "grippe" and the influenza during the great epidemic. Eight years before patient had had her upper teeth removed because of abscesses (Fig. 1). Two months later she noticed teeth of lower jaw loosening so that if one was moved all the teeth moved with it. A week later she had these lower teeth removed. She suffered pain in mandible and had pus drain from it. The following year, after jaw had completely healed, she had dentures made. These were satisfactory and jaws gave her no more trouble until present illness.

Present Illness: Patient, when five months pregnant, felt a dull ache in the right mandible, which continued until August of that year, when her baby, then three months old, hit her in the right side of jaw at various times. Each time this caused severe pain and a "grating feeling". For this condition she went to a hospital in Maine, where roentgenograms were taken, which showed extreme atrophy of mandible with fracture on

the right side (Fig. 2). Treatment was symptomatic. She returned home and suffered pathological fracture on left side of mandible from merely swallowing while in bed. She suffered a great deal of pain and returned to the hospital, where further x-ray studies were made. She was referred by a friend to the Massachusetts Memorial Hospital in Boston. A roentgenographic examination made at that time showed "thin detached sequestrum of anterior and lateral portions of lower jaw". She was relieved by alcohol injections and was discharged.

FIG. 2

Roentgenogram of mandible taken August 31, 1926, showing bone atrophy and fracture.

When the writer examined the above roentgenogram recently, it occurred to him that it had been overexposed, and he had the photographer reduce it. The finer detail of the plate then became visible (Fig. 3). From this picture it appeared that at that time the anterior part of the mandible had become atrophied and had been bent down by the flexor muscles at the place of the former fracture. This was later borne out when the two roentgenograms (Fig. 2) were received from the hospital in Maine (courtesy of Dr. F. B. Ames). The piece of bone, in the opinion of the writer, was not a sequestrum, but rather a broken fragment of live bone.

During the following thirteen months patient showed little improvement. She was readmitted to the hospital and after symptomatic treatment she was transferred to the Evans Memorial Hospital for more study. Her physical examination was normal save that she was under weight (seventy-eight pounds). X-ray examination showed all bones of skeleton normal, except the mandible; resorption of the entire mandible, including rami and condyle of the mandibular joints, had occurred (Fig. 4). At home she kept house, worked hard, and lost a little weight. Her jaw

FIG. 3

Roentgenogram of mandible taken October 1, 1926, showing anterior fragment of mandible pulled down by muscles. Note enlarged mandibular canal.

FIG. 4

Roentgenogram of skull taken April 30, 1928. Calvarium normal. Sela turcica normal. Mandible completely absent; maxilla normal except for atrophy of alveolar process, a condition normal after extraction of all the teeth.

FIG. 5

Appearance of face, April, 1932, showing normal position of chin.

FIG. 6

Appearance of face, April, 1932, showing how chin can be pressed to pharyngeal wall.

ached only at times. After wearing dentures for a while, she ate (without her teeth) a deficient diet of meat, potato, white bread, and canned vegetables. She liked butter; ate practically no eggs; drank coffee, but no milk.

In April, 1932, she was examined by the writer at his office. She then appeared as a very thin woman, in no obvious distress. Facial expression was unusual, due to marked retrusion of lower jaw (Fig. 5). Chin could be pushed to pharynx without pain (Fig. 6).

Physical Examination at the Evans Memorial Hospital showed a not too well developed white woman of thirty-six years. A slight exophthalmos was present. What appeared to be thin layers of adipose tissue beneath the bulbar conjunctivae were encroaching toward the cornea from both inner and outer angles of both eyes. Hearing was normal; no discharge or mastoid tenderness. There was no discharge or obstruction of nose. Tonsils were small and not inflamed. There was a slight enlargement of the thyroid on the right and a few large anterior cervical lymph glands.

Four years before, over the left lower lung posteriorly, there was slightly increased tactile fremitus, considerable increase in vocal fremitus, very slight comparative dullness and fine moist râles on deep inspiration only. There was no friction rub, and the lungs were otherwise normal. In 1932 all signs were normal.

Heart sounds were regular and of good quality, with no murmurs, thrills, or evidence of enlargement. The abdomen was normal. Kidneys and spleen were not palpable; the liver was not enlarged. The skin was normal. No axillary or inguinal glands were found. Two glands smaller than peas could be palpated in the left anterior cervical chain; they were not tender. No bowing of long bones; epiphyses normal; hands, fingers and nails normal. No oedema or cyanosis.

Neurological Examination: Sensory response to light, touch, sharp and dull points, heat and cold were normal, with possible exception of distribution of trigeminus, where there was questionable decrease in sensation of conjunctiva of left eye. Cranial nerves were otherwise intact, save possibly the auditory (eighth cranial) as evidenced by poor station with slightly increased swaying. Coordination was normal except on left forefinger-to-nose test, which shows pass-pointing by two centimeters on repeated trials (1928). No tenderness over nerve trunks or demonstrable disturbance of sensation. No tremors, atrophies, or palsies. Train and content of thought normal. Reflexes normal, active and equal.

Laboratory Examination (Evans Memorial Hospital):

Urine: Normal on repeated examinations.

FIG. 7

Roentgenogram of jaws taken April 25, 1932. Mandible completely resorbed. There is evidence of atrophy of tuberosity of maxilla, palatine bone, and internal pterygoid plates and hamular process of sphenoid.

FIG. 8

Biopsy from premolar region in left maxilla where roentgenogram showed active resorption. (× 36.)

Later showed slight trace of albumen, but never any casts or other pathology. Blood: Normal morphology and blood chemistry (non-protein nitrogen, urea nitrogen, uric acid, creatinin, phosphorus, and calcium). Sugar was 108 to 125 milligrams per hundred cubic centimeters of blood, but down to eighty-seven milligrams per hundred cubic centimeters of blood later. Cholesterol was 286 milligrams per hundred cubic centimeters of blood.

Wassermann and Kahn were both negative on repeated tests. Sputum, negative. Spinal fluid, negative. Renal function, normal (phenolsulphonephthalein test). Liver function, normal (galactose tolerance low; ten to twenty grams to less than ten grams). Basal metabolism, low (minus twenty per cent., Boothby-Sandford standard). Vital capacity, low (minus twenty-one per cent., Dreyer).

Roentgenographic Examination: (Dr. A. W. George and Dr. R. D. Leonard). At this

time, x-ray showed bones of entire skeleton normal, save skull. No evidence of osteomalacia or generalized osteitis fibrosa. The mandible was completely resorbed; the maxilla showed resorption of the alveolar process in the posterior part. Tuberosity was resorbed with the pterygoid plate and pterygoid hamulus of sphenoid. Only the cortical bone of the maxillary sinus remained. In the anterior part was evidence of resorption of the alveolar process (Fig. 7). (See Figure 4 taken four years before.)

Pathological Examination: In discussing this case Dr. Ludwig Pick of Berlin, who was visiting Harvard, expressed the opinion that the patient's condition must be due to a "brown tumor of von Recklinghausen's disease" and that biopsy of an affected part would prove his contention.

FIG. 9

Biopsy showing large vascular space in trabeculae. (× 700.)

Operation: Under local anaesthesia, a vertical incision was made in the premolar region of the left maxilla. Apparently the bone had resorbed, for the knife passed upward without resistance for one and one-half centimeters (it usually strikes bone at about one-quarter centimeter). Bone was then cut with saw. In removing a small section with chisel, bone became loosened from the soft tissue and the two were removed together, a mass about one and three-quarters centimeters in diameter. The wound was closed with sutures and healed uneventfully.

Microscopic Examination: (Dr. G. A. Bennett, Department of Pathology, Harvard Medical School). "The largest tissue fragment (Fig. 8) is bounded on two sides by stratified epithelium, which shows numerous long, narrow papillae extending into the subepithelial tissue. Beneath the epithelium is a thick layer of connective tissue, which is peculiarly divided into small subdivisions by blood vessels and capillaries. The connective-tissue bundles, while not very dense in texture, do not contain many nuclei. Many more nuclei, together with a scattering of plasma cells and mononuclear leucocytes,

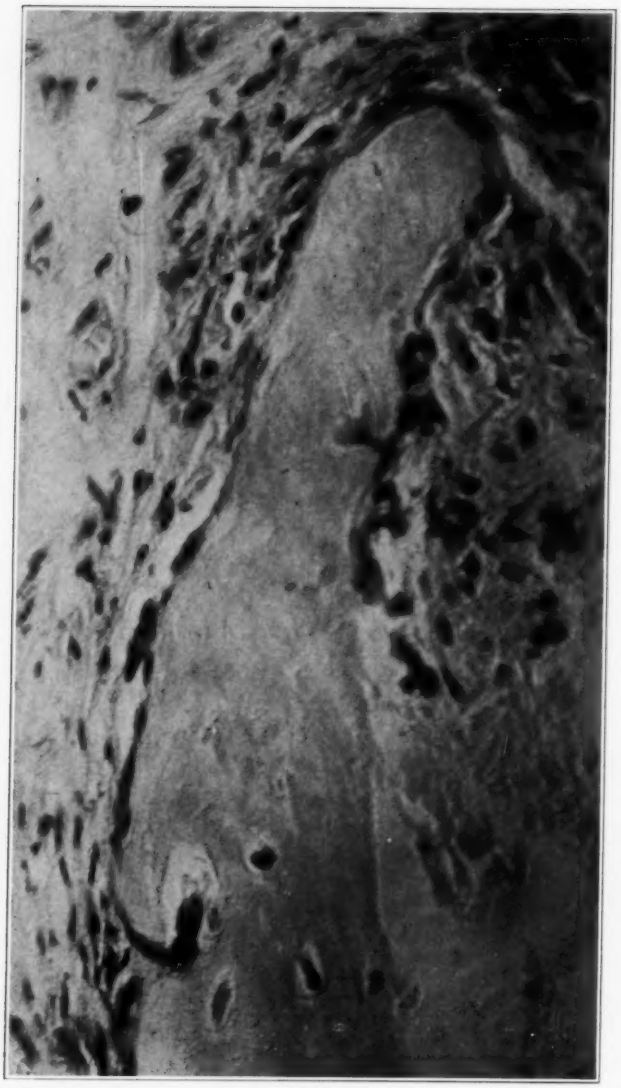

FIG. 10
Biopsy showing trabeculae. (× 700.)

are present around capillaries. In the deepest portion of this section are found a number of bone fragments. The bone changes seen in these are essentially the same. In the light of the history of this case, they are difficult to interpret. Some degree of porosis or atrophy is indicated by the relative amounts of bone trabeculae and marrow tissue and by the relatively large, vascular spaces in the bone trabeculae (Fig. 9). Evidence of resorption of bone is almost entirely lacking, although there are slight notching and marginal irregularities in a few of the trabeculae (Fig. 10). On the other hand, there is evidence of feeble apposition of osteoid in scattered areas. In such instances a layer of osteoblastic cells overlies the osteoid deposit. On the whole, the marrow tissue is fatty. There are, however, a few areas in which it appears that a condensation of marrow blood vessels and fibrous tissue has occurred. Such a condensation may be due to atrophy of bone trabeculae. An adequate diagnosis from the histology of this tissue is not possible; hence, it will be cataloged under the diagnosis of 'Bone Atrophy'. There is no evidence of any inflammatory processes or generalized osteitis fibrosa (hyperparathyroidism)."

Blood Calcium: Blood calcium study was made at this time by Dr. J. C. Aub and found to be within normal limits (serum calcium, eleven and two-tenths milligrams; serum phosphorus, three and six-tenths milligrams; no phosphatase run). Wassermann and Kahn reactions were negative. Patient has never had any contact with phosphorus lead, arsenic, radium, or mercury.

Diagnosis: Progressive atrophy of the jaws; complete atrophy of mandible.

Subsequent Course: Patient was prescribed a more balanced diet, relatively rich in

calcium, phosphorus, and vitamins (dairy products) and was given in addition viosterol and cod liver oil. This she followed faithfully and, when seen two months later, she showed considerable gain in weight and well-being. When again admitted to the Evans Memorial Hospital, three months later, she stated that she felt well during the summer, worked hard at household duties and canning fruit. She kept strictly to the diet prescribed, but had to eat without her artificial teeth. She again had lost some weight. Late in summer, she suffered a head cold; at least, there was discharge from her nose. Also pains came back; aching and throbbing and constant pains were felt, especially running across the right cheek and radiating to the temporal region and to the ear.

Roentgenographic Study: Further resorption of the maxilla had occurred. The posterior wall of the maxillary sinus had been completely resorbed, but the calvarium, chest, and long bones were still entirely normal.

The disease no doubt was initiated by dental infection. This infection, however, was completely cleared up by extraction of the teeth and subsequent treatment. During a long interval, the jaw was normal and dentures were worn with comfort. At the end of her third pregnancy, pain started to appear in her jaws, which was the first indication of the disease. The pathological process at that time apparently caused fragility of the bone, which predisposed to pathological fracture from such a trivial cause as a blow from the fist of an infant.

The roentgenogram, taken at that time, showed progressive atrophy of the mandible beyond the ordinary atrophy seen after extraction of all the teeth. The one important feature in the early roentgenographic picture was an abnormally large mandibular canal (Fig. 3). There was no evidence of infection in the bone at that time. In twenty months the mandible was completely resorbed, leaving a flexible membrane in the place of the jaw.

During the four years following, the disease progressed further, involving various parts of the maxillary, palatine, and sphenoid bones. The few facts which can be summarized are:

1. The disease is progressive.
2. It involves the bones in the distribution of the fifth cranial (trigeminus) nerve; no evidence of hyperparathyroidism.
3. There persists a certain amount of pain in the distribution of this nerve.
4. All other bones are normal.
5. With increased calcium and vitamins in the diet, patient has for a time been gaining weight, but bone condition has been getting progressively worse.
6. The involvement of bones in the distribution of the fifth cranial nerve and its ganglia, and the persistent pain connected with the bone resorption, suggest classification of the disease as neurotrophic atrophy.

1. Absorption of the Humerus After Fracture. Boston Med. and Surg. J., LXXXVII, 245, 1872.

DOES A SUCCESSFUL FUSION OF THE TUBERCULOUS HIP CURE THE TUBERCULOUS PROCESS?

BY C. F. EIKENBARY, M.D., AND JOHN F. LECOCQ, M.D., SEATTLE, WASHINGTON

Within recent years many surgeons, following the lead of the late Dr. Russell Hibbs, have taken the attitude that all tuberculous hips should be fused, and that a successful fusion ended the infection. Within certain bounds, we have been, and still are, in accord with that view. Without wishing, at this time, to go into the details as to treatment, we might state that we feel that where destruction has not actually taken place, the conservative treatment—prolonged traction and sunshine, etc.—has a definite place. We also feel that fusion should not be done in children before the age of six or seven, owing to the lack of bony development requisite to a successful fusion. The following case, with autopsy findings, is presented in the hope that it may make a slight contribution to our knowledge of the above problem.

FIG. 1

Roentgenographic appearance one year after fusion.

FIG. 2

Photograph of hip at autopsy.

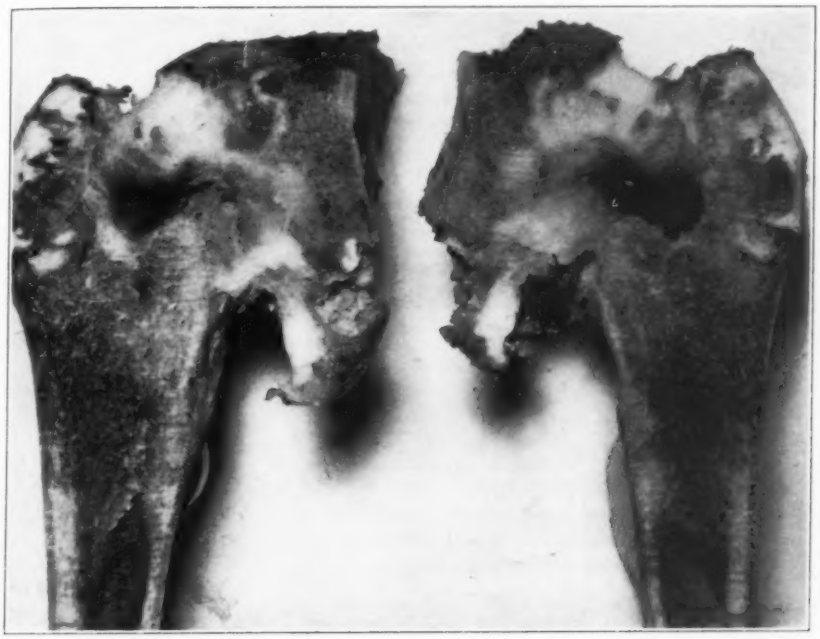

FIG. 3

Transverse section of hip and portion of ilium. Solid, bony fusion. Tuberculous area still present.

H. E., aged eleven, was admitted to the Children's Orthopaedic Hospital May 22, 1928, with a diagnosis of tuberculosis of the hip. Conservative treatment was tried and failed. Fusion operation was performed on March 18, 1929. Guinea-pig inoculation, following the fusion, established the diagnosis of tuberculosis of the hip. The boy made an uneventful recovery and was discharged from the hospital a little over a year later, cured, as shown by clinical and roentgenographic examination. For a period of a little over two years, the boy was perfectly well, the hip being solidly fused. There was no pain, and the boy led the usual active life. He could run up and down stairs without difficulty and had only a slight limp. We considered the result to be extraordinarily good.

Two years after we had dismissed him as cured, the boy was readmitted to the hospital with the clinical symptoms of tuberculous meningitis. He died two weeks later and the autopsy findings were quite typical of tuberculous meningitis. The upper end of the femur and a portion of the ilium were removed for examination purposes. The photograph of the hip, together with roentgenograms made after removal, are herewith presented. A solid bony fusion was evident, but in the upper end of the femur and in the remnant of the neck, there were present several typical tuberculous areas. This was confirmed by microscopic examination.

Comment is probably unnecessary. Certainly the findings prove quite clearly that a successful fusion does not necessarily end the tuberculous process. However, we feel that the above case must be most unusual, and the final result does not materially detract from the value of the operation.

CONGENITAL ANOMALY OF THE LEFT FEMUR

BY JULIUS S. NEVIASER, M.D., WASHINGTON, D. C.

Congenital anomalies of the femur are very uncommon, and this case is reported because a review of the literature does not reveal a similar condition. Again, it is of extreme importance that every case of rare congenital deformity coming under the care of the surgeon should be reported, as it may be helpful in further investigations both of an embryological and an anatomical nature. The questions as to whether syphilis plays any part in the etiology, and what form of treatment could be used in this case, are both interesting problems.

CASE REPORT

R. A., female, aged twenty months, was born with a short left leg. This was the first child, pregnancy and labor being without difficulty. The parents have positive Wassermann tests, although the child's Wassermann test was negative. The second child, recently born, is apparently normal in all respects.

FIG. 1

The child started to walk at the age of nineteen months.

Physical Examination: White female, well nourished for her age. Except for the left lower extremity which is much shorter than the right, the examination was negative. In the recumbent position the child held the left lower extremity in the frog position. Upon standing on the right leg, the left was held in ninety degrees' external rotation. The child could stand on the left leg by flexing the right knee. Strength of the muscles was good.

Measurements:

Anterior superior spine: right, fourteen inches; left, eight and one-quarter inches.
Angle of greatest extension: left knee, 160 degrees; right knee, 180 degrees.
Length of right tibia, five and three-quarters inches.
Length of left tibia, four and three-quarters inches.

Roentgenographic Findings: There is a congenital abnormality of the left femur with a complete absence of the upper half of the femur. The lower portion of the shaft gradually tapers to a point, and ends five centimeters above the epiphyseal line. The upper extremity of this rudimentary bone lies external and superior to the site of the acetabulum, which is undeveloped. The knee joint is clear and normal.

The right femur is normal in development, and measures sixteen centimeters from the upper to the lower epiphyseal line. The right hip and knee joints are normal.

From an etiological standpoint it is doubtful if syphilis plays any rôle. The second child born was normal. However, Bloom, Stone, and Henriques reported a case where lues was present. It can be seen that in future cases of this type it will be important to rule out any luetic factor.

As to treatment, it was planned to give the child a light brace to equalize the length of the legs. When the child grows a little older and stronger, and, if it is found that the hip joint is unstable, a shelf operation will be considered, with an implantation of a bone graft reaching from the ilium down to the shortened femur. Although this may not overcome all of the shortening, it should give a stable hip and the child would be able to wear a smaller brace.

BIBLIOGRAPHY

1. Alegiani, U.: Congenito Difetto del Femore. Policlin., Sec. Chir., Roma, XIII, 404, 1906.
2. Berg, Sylva: Ueber Kongenitalen Femurdefekt. Ztschr. f. Orthop. Chir., XLV, 397, 1924.
3. Blencke: Ueber Congenitalen Femurdefect. Ztschr. f. Orthop. Chir., IX, 584, 1901.
4. Bristow, W. R.: Congenital Malformation of the Right Femur. Proc. Roy. Soc. Med., XIII, Sect. Surg. 203, 1919–20.
5. Hamann, C. A.: An Abnormality in the Form of the Femur. Cleveland Med. J., IX, 710, 1910.
6. Manouvrier, L.: Étude sur les Variations Morphologiques du Corps du Fémur dans l'Espèce Humaine. Bull. Soc. d'Anthrop. de Paris. Série 4, IV, 111, 1893.
7. Reiner, M.: Ueber den Congenitalen Femurdefect. Ztschr. f. Orthop. Chir., IX, 544, 1901.
8. Bloom, C. J., Stone, R. E., and Henriques, A.: Three Unusual Cases of Congenital Origin. Arch. Pediat., XXXIV, 512, 1917.
9. Theobalds, F.: Congenital Deformity of Femur. British Med. J., I, 532, 1914.

SEPTIC ARTHRITIS IN THE HIP CAUSED BY BRUCELLA MELITENSIS

Report of Case

BY ARCH F. O'DONOGHUE, M.D., F.A.C.S., SIOUX CITY, IOWA

It is not our intention to add to the already voluminous literature on Malta fever in this country, which has been sporadic for twenty-five years, and which in recent years is becoming endemic, especially in the Middle West. The disease has been well described by a number of writers, the first human case being reported about 1905. Since then Fortney [1], Gillen and Gordinier [2], Keefer [3], Potts *et al.* [4], Simpson and Bowers [5], and numerous others have well described the disease. However, while practically all writers who observe more than one case note that there are arthralgic symptoms present in most cases, there are in the literature no reports of actual pus formation in joints with their destruction, except that by Kulowski and Vinke [6], from Steindler's Clinic. We wish to add to the literature a case which recently came under our observation because we

Fig. 1

Preoperative roentgenogram, April 4, 1931, showing cloudiness over right hip area.

feel that—especially in the cattle-raising portions of the Middle West—septic joint involvements may often be due to Malta fever, and that joint infections from this cause are probably more common than has been suspected, especially since the differential diagnosis between septic monarticular arthritis of non-specific origin, tuberculous arthritis, and some other types might easily be overlooked.

REPORT OF CASE

A white girl, aged twelve, living in northern Nebraska, came into the Lutheran General Hospital at Sioux City, in the Service of Dr. I. E. Nervig, on February 25, 1931. She complained that for the previous six weeks she had suffered afternoon rise in temperature, marked malaise, headaches, and occasional chills. Her family history was essentially negative. The family kept a number of cattle on the farm, but the father denied any abortions in the herd in recent months.

Her general examination was essentially negative, at that time, except for her very apparent loss of weight and rather exhausted appearance. Laboratory examination showed the urine to be normal, hemoglobin seventy-two per cent., leukocyte count 10,700 with a slight relative lymphocytosis; Wassermann, tuberculin, and Widal tests were negative, but the Malta fever agglutination was positive in dilutions of 1:160. She stayed in the hospital from February 25, 1931, to March 23, 1931, during this period being treated by Dr. Nervig by the use of intravenous mercurochrome, injections of which were followed by chills and temperature ranging up to 104. She left the hospital in March 1931, still running an afternoon temperature, but her general condition was much improved.

She came into the hospital again on April 1, 1931, complaining of excruciating pain in the right hip area with chills and fever. We were asked to see her on April 4, on which day our examination showed a very sick-looking girl whose general examination was negative, except that she lay with the right lower extremity in complete external rotation and about forty-five degrees' abduction, screaming with pain on the slightest movement of this hip, even touching the bed causing intense pain. Glands in the right groin were markedly enlarged and quite tender on slight pal-

FIG. 2

Postoperative roentgenogram, July 31, 1931, showing complete bony ankylosis.

pation. The spleen was palpable and slightly enlarged. Other glands showed no changes. Laboratory examination on this date showed her urine to be normal, hemoglobin sixty-eight per cent., white count of 10,350 with thirty-nine lymphocytes and a positive agglutination test for Malta fever of 1:160. Comparative roentgenographic studies made of both hips showed slight cloudiness of the right hip joint with probable bulging of the capsule. We therefore advised and did a radical drainage of the hip on April 6, approaching the hip by the Smith-Petersen route. A large amount of thin pus was evacuated and, as the exposed head was pink, a gutta-percha drain was inserted into the posterior limb, the anterior limb being closed, and no Orr pack used. A culture taken from the pus removed from the wound showed no growth until the ninth day, when a typical Brucella melitensis was found by Dr. A. C. Starry of the hospital laboratory. A spica cast was applied immediately following the operation. The patient's temperature subsided at once and she left the hospital in the cast seventeen days after the operation. She was kept in plaster until July 31, 1931, on which date the cast was removed; all wounds were healed, and the roentgenograms showed a solid bony ankylosis of the hip. She was advised to wait a year or two and then have an arthroplasty done.

SUMMARY

A case of septic arthritis in the hip, caused by the Brucella melitensis and resulting in a solid ankylosis of the hip, is reported.

Malta fever joint infections must be added to the lesions calling for differential diagnosis of acute and subacute joint conditions.

BIBLIOGRAPHY

1. Fortney, A. C.: Undulant Fever. Minnesota Med., XIV, 691, 1931.
2. Gillen, H. B., and Gordinier, H. C.: Undulant Malta Fever, With a Report of a Case. New York State J. Med., XXVIII, 581, 1928.
3. Keefer, C. S.: Report of a Case of Malta Fever Originating in Baltimore, Maryland. Johns Hopkins Hosp. Bull., XXXV, 6, 1924.
4. Potts, R. H., D'Aunoy, R., Knight, M. J., and Beven, J. L.: Undulant Fever; Report of First Louisiana Case. Med. J. and Rec., CXXX, 367, 1929.
5. Simpson, W. M., and Bowers, L. G.: Surgical Aspects of Undulant Fever. Am. J. Surg., VIII, 597, 1929.
6. Kulowski, J., and Vinke, T. H.: Undulant (Malta) Fever Spondylitis. Report of a Case, Due to Brucella Melitensis, Bovine Variety, Surgically Treated. J. Am. Med. Assn., XCIX, 1656, 1932.

OSTEITIS FIBROSA CYSTICA AT AN UNUSUAL AGE*

BY EDWIN L. RYPINS, M.D., IOWA CITY, IOWA

Osteitis fibrosa cystica is generally regarded as a disease of youth (Bloodgood [2], Geschickter and Copeland [3], Platou [9]); and the common age is before twenty (Bloodgood, Platou), although Kilgore and Garland [6] report a case in a man of forty-six. We find few cases reported in infants. Thus, we believe the following case report may prove of interest.

FIG. 1

Appearance of right tibia on entrance. Note that the lower end of the fibula is almost fractured.

* From the Department of Roentgenology, University Hospital, University of Iowa, Iowa City, Iowa.

FIG. 2

Approximately ten weeks later. Note that the lower end of the fibula has fractured. There has not been any trauma in the interval.

R. S., female, white, American, twenty months of age, was admitted to the Orthopaedic Hospital of the State University of Iowa on December 18, 1931, Service of Dr. Arthur Steindler, complaining of pain and limp in the right leg. Symptoms dated from September 1931, at which time the patient first attempted to walk. The limp had been steadily progressive. Family and past history were negative. On examination the patient walked with the right leg externally rotated and the knee locked, as in quadriceps weakness. The right tibia was bowed anteriorly and laterally, and thickened.

The tuberculin and blood Wassermann reactions were negative. The blood calcium was eleven milligrams; the blood phosphorus five and two-tenths milligrams. The right leg was placed in a cast for two months without improvement.

Biopsy of right tibia on March 13, 1932, showed osteitis fibrosa cystica. Guinea-pig injection of material failed to reveal tuberculosis.

Immobilization in another cast gave a great deal of relief, but one month of weight-bearing caused more bowing of the right tibia.

DISCUSSION

Burchard, as quoted by Joseph [5], has roentgenographic proof of bone cysts in a child at eighteen months of age, and Joseph himself reports a case in which the patient was thirteen months old. In this latter case a biopsy of an inguinal gland was reported as metastatic sarcoma, which would make one suspicious that the bone lesions might also be malignant.

Apparently there is a close relationship between osteitis fibrosa cystica, bone cysts, and giant-cell tumor of bone, as Platt [10], speaking of giant-cell tumor and osteitis fibrosa cystica, states, "The two lesions have a common histological denominator, the giant-cell area", while Geschick-

ter and Copeland [3], state, "The average solitary bone cyst in the long bones is a healed or healing giant-cell tumor". Also, "the polycystic groups of osteitis fibrosa also emphasize the relation of the bone cyst to giant-cell tumor tissue, for in these lesions the small young cysts can be seen arising in giant-cell areas and fusing together to form the larger cavities".

The blood calcium was found to be normal; this test was done because, as Barrie [1] remarks, "Recent investigations seem to show that the parathyroids play a rôle in calcium content control. Faulty bone metabolism is quite generally believed to be due to an interference with endocrinal glandular equilibrium."

Furthermore, J. J. Morton [8] states that von Recklinghausen first regarded the disease as an inflammatory process whereby fibrous tissue was substituted for bone structure, while in his later work he changed this belief and thought that he was dealing with a metaphase of existing tissue and a calcium withdrawal.

However, Salmon [11] states, "Gold and Schlesinger find no parathyroid changes in localized osteitis fibrosa, but in the various generalized forms they find a definite association". Hunter and Turnbull [4] report four cases of focal osteitis fibrosa in order "to place on record the absence of any evidence of hyperparathyroidism in this disease".

E. G. Slesinger [12] gives two good theories regarding pathogenesis of osteitis fibrosa cystica,—(1) "It represents a metaplastic transformation of the bone marrow into a fibroid tissue; (2) it is the result of a chronic inflammation of unknown origin occurring in the endosteum." Furthermore, Slesinger feels that trauma is an important factor, a view not held by Bloodgood.

THERAPY

The close relationship of benign giant-cell tumors, which readily respond to radiation therapy, and osteitis fibrosa cystica would indicate that radiation therapy, as suggested by LeWald [7], might prove of value in both conditions. We have not had an opportunity to treat this case.

SUMMARY

1. A case of osteitis fibrosa cystica in an infant, aged twenty months, is reported; reports of only two younger cases have been found in the literature.

2. Radiation therapy might prove of value in this condition, due to the close relationship of osteitis fibrosa cystica and giant-cell tumor.

BIBLIOGRAPHY

1. Barrie, G.: Fibrocystic and Cystic Lesions in Bone. Ann. Surg., LXVII, 354, 1918.
2. Bloodgood, J. C.: Bone Cysts. J. Am. Med. Assn., XLIII, 1124, 1904.
3. Geschickter, C. F., and Copeland, M. M.: Osteitis Fibrosa and Giant Cell Tumor. Arch. Surg., XIX, 169, 1929.

4. Hunter, D., and Turnbull, H. M.: Hyperparathyroidism: Generalized Osteitis Fibrosa. British J. Surg., XIX, 203, Oct. 1931.
5. Joseph, B. M.: Osteitis Fibrosa Cystica, Generalized Type, with Giant Cell Sarcoma. Am. J. Dis. Child., XL, 81, 1930.
6. Kilgore, A. R., and Garland, L. H.: Osteitis Fibrosa Localisata. Radiology, XVI, 679, 1931.
7. LeWald, L. T.: Roentgen Therapy of Giant-Cell Tumor and Osteitis Fibrosa Cystica. Radiology, XV, 136, 1930.
8. Morton, J. J.: The Generalized Type of Osteitis Fibrosa Cystica. Arch. Surg., IV, 534, 1922.
9. Platou, E.: On Osseous Cysts and So-Called Giant-Cell Sarcoma. Ann. Surg., LXVII, 312, 1918.
10. Platt, H.: Cysts of the Long Bones of the Hand and Foot. British J. Surg., XVIII, 20, July 1930.
11. Salmon, L. A.: Parathyroid Disturbances. J. Nervous and Mental Dis., LXXV, 291, March 1932.
12. Slesinger, E. G.: Osteitis Fibrosa. Lancet, II, 867, 1919.

THE USE OF UNNA'S PASTE IN THE MAGGOT TREATMENT OF OSTEOMYELITIS *

BY E. L. JEWETT, M.D., HARTFORD, CONNECTICUT

Hartford Hospital, Hartford, Connecticut

In a review of the literature pertaining to the Baer maggot treatment of osteomyelitis, we find that the only substances used to cover the skin edges and hold the wire or gauze covering are adhesive tape, rubber plastic, or collodion. Most of the writers state that the patients have complained more or less of irritation of the skin by the maggots. We find that both adhesive and rubber plastic not only lead to irritation of the skin when removed, but that they also separate from the skin in many cases, thus allowing the maggots to creep up on the skin. As each series of treatments consists of a number of applications of maggots, with new covering each time, the above condition at times proves of real import. In one patient it was necessary to give quite large doses of antipruritics and hypnotics to enable him to be comfortable and sleep.

This led us to try Unna's paste as a medium to fasten the covering to the skin. The formula we used is:

Zinc oxid, 2½ parts
Gelatin, 6¼ parts
Glycerin and water, each 19 parts

The solution should not be too thin, or it will run down over the leg and also into the wound, but when of the right consistency (this can be determined by trial) it seals the skin very effectively and also keeps the covering of wire or gauze glued down. Of course, it should be applied warm. We have seen no ill effects from a little of the paste getting into

FIG. 1

Application of Unna's paste.

* Through the courtesy of Dr. John H. T. Sweet, Jr., on whose Private Room Service was developed the following method of application of wire retaining screen in the maggot treatment of osteomyelitis.

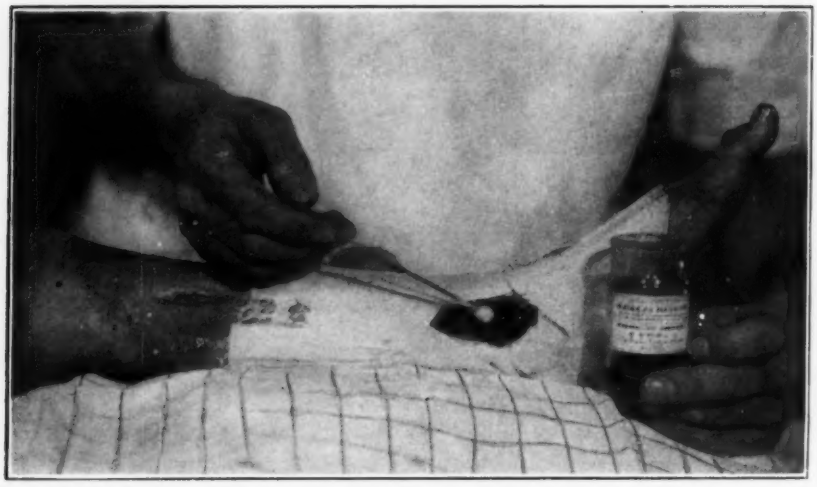

FIG. 2

Method of application of maggots to lesion.

the open wound. We found that the maggots could be implanted in the wound effectively by the use of sterile gauze applicators which had been dipped in the maggot suspension. If the maggot-laden applicators are left in the wound for a moment or two, most of the maggots wander off from the cotton into the wound.

At first we used thick felt as a framework on which to put the wire gauze and this seemed to work very well, if the felt was thoroughly saturated with the paste and all the crevices closed with the paste. Later on we discontinued the use of the felt, just using ordinary gauze. The

FIG. 3

Showing one wire screen covered with Unna's paste and gauze and another screen with edges turned down, to be applied to lesion on opposite side of leg. Adhesive tape has not yet been applied.

edges of the wire should be turned over so that no loose strands are left free to cause irritation to the underlying skin. After the wire is fitted over the lesion, more layers of Unna's paste and gauze are placed, overlapping the wire edges. Then, as a final covering, adhesive tape is placed over the gauze. In cases where there is any question of the covering not being tight, ordinary gauze bandage may be wound firmly around everything else and left on until the paste thoroughly hardens. A few layers of gauze left over the wire mesh for a few hours are not enough to keep out the air.

The advantages of this covering are as follows:

1. It produces no irritation to the skin.
2. The paste can be placed close to the open lesion and all cracks and crevices effectively sealed off, thus confining the maggots to the lesion. The secretions from an osteomyelitic lesion often saturate the adhesive tape and cause it to separate from the skin. These secretions themselves are somewhat irritative to the skin. This paste protects the skin from these secretions.
3. It can be washed off easily with warm water and this leaves the skin in excellent condition.

TREATMENT OF VOLKMANN'S ISCHAEMIC PARALYSIS BY ELASTIC TRACTION

Report of Seven Cases *

BY ATTILIO MILICI, M.D., NEW YORK, N. Y.

Since 1928 the writer has treated seven cases of Volkmann's paralysis with elastic traction. Though traction is not a new method, and the means by which it is applied has been used by others, these cases are being reported because of certain details which have made this form of treatment more effective. The splint (Fig. 1), made of an ordinary metal that is not too pliable, consists of a proximal part (*A*) for the forearm and a distal part (*B*) for the hand, the two connected by an ordinary door-hinge (*a*),

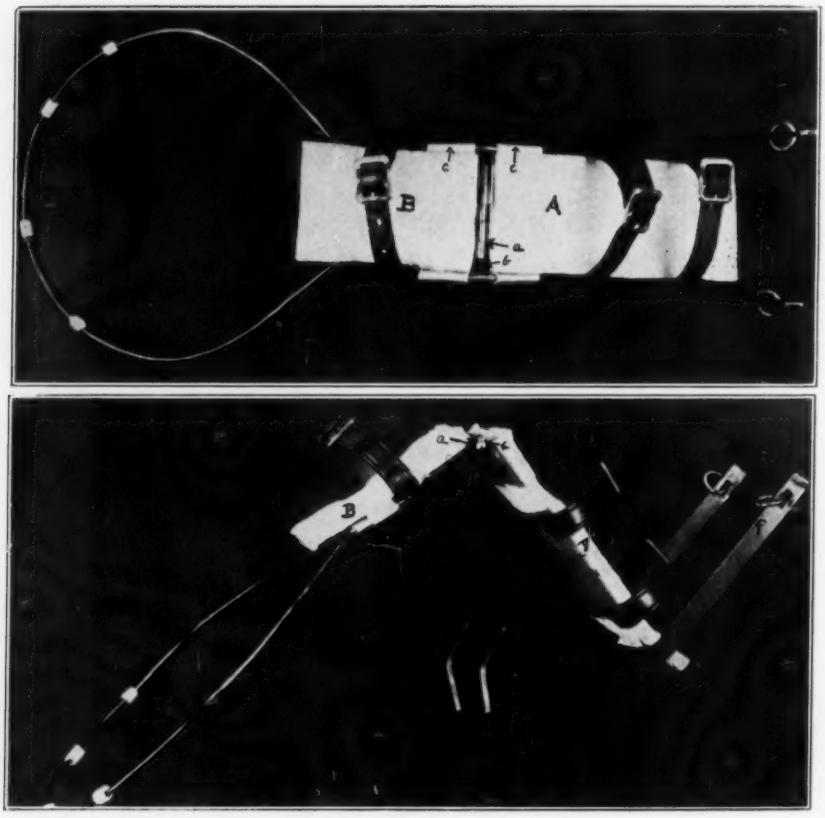

Fig. 1

Splint. *A*. Proximal portion for forearm. *B*. Distal portion for hand and fingers. *a*. Ordinary door-hinge. *b*. Removable pin of door-hinge. *c*. Grooves for insertion of removable pins. *d*. Removable pins which can be bent to any angle. *e*. Wire loop for extension. *f*. Vertical bars for traction on distal portion of splint.

* From the Children's Surgical Service, Bellevue Hospital, New York City.

so that the distal part can be moved on the proximal to any desired position. A removal pin (*b*) in the hinge makes it possible to separate the two parts of the splint by simply pulling the pin out.

At the wrist the two parts of the splint on either side have a groove (*c*) through which a small metal rod (*d*) can be inserted, thus immobilizing the movable part of the splint. (Metal rod *d* is inserted in the grooves *c*.) Immobilization of the distal part of the splint in any desired position can be accomplished by simply bending the rod (*d*). A loop of wire (*e*), spreading out banjo-fashion from the end of the splint, serves as a medium to hold the elastic traction. This wire loop is removable, being held in position by slots in the distal portion of the splint.

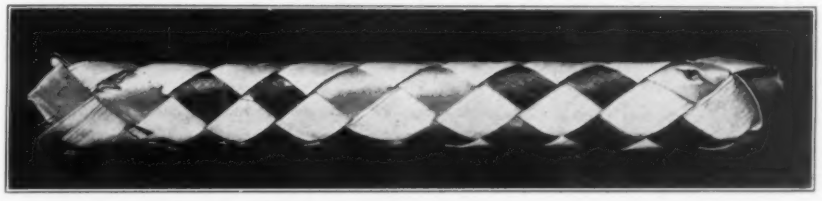

FIG. 2
Japanese finger trap, used for extension.

Traction is made on the fingers by means of the so called Japanese finger traps (Fig. 2). These finger traps are made of woven straw and are intended to be used as trick toys. Inserting a finger of each hand on either end of the toy it is impossible to extricate them, as the more one pulls, the tighter the grip becomes; the fingers, however, can be quickly released by approximating the two ends of the finger traps towards each other. We make use of these traps by attaching a piece of Esmarch's bandage to one end and inserting the other end over the finger. Traction is made by the pulling of the rubber which in turn is fastened to the banjo wire by an ordinary curtain hook (Fig. 3). The amount of tension exerted is regulated by lengthening or shortening of the rubber band. The fingers are covered with strips of adhesive plaster to protect them from the slight roughness of the straw and also to obtain a firmer grip. The great advantage of these finger traps is that they can be instantly applied; can be removed as quickly; the hold on the fingers is firm; and, on account of their great resiliency, they do not interfere with the circulation of the part.

The traction is begun on the fingers by immobilizing the splint in the position in which the fingers lie, and is continued until their complete extension in that position is attained. The angles of the immobilizing pins are then changed into less acute ones, thus immobilizing the palmar portion of the splint a few more degrees toward dorsiflexion, and traction again is made on the fingers until they are straight in this particular plane; immobilization is thus gradually changed into a more dorsiflexed position and traction continued until both wrist and fingers are on the same horizontal plane (Fig. 3).

It has been learned from experience that the elasticity of the muscles in these cases is greatly diminished, and that the tendency to correction increases with improvement of position.

In all of the cases it was found that after the wrist and fingers were corrected to a horizontal plane, no further progress could be made. It was considered advantageous at this stage to discontinue traction on the fingers; to remove the immobilizing pins (*d*), thus allowing the distal part of the splint to move on the proximal; and to make traction in a dorsiflexed position on the wrist by the use of an ordinary Esmarch's bandage attached to a vertical bar (Fig. 1, *f*) on either side of the splint near the elbow and on the banjo wire at the finger end of the splint (Fig. 4), the Esmarch being regulated so as to have a slight tension at all times. It has been found more practical at this stage to encase the splint and the forearm in plaster-of-Paris, first removing the straps, which up to this time, have been used (Fig. 4).

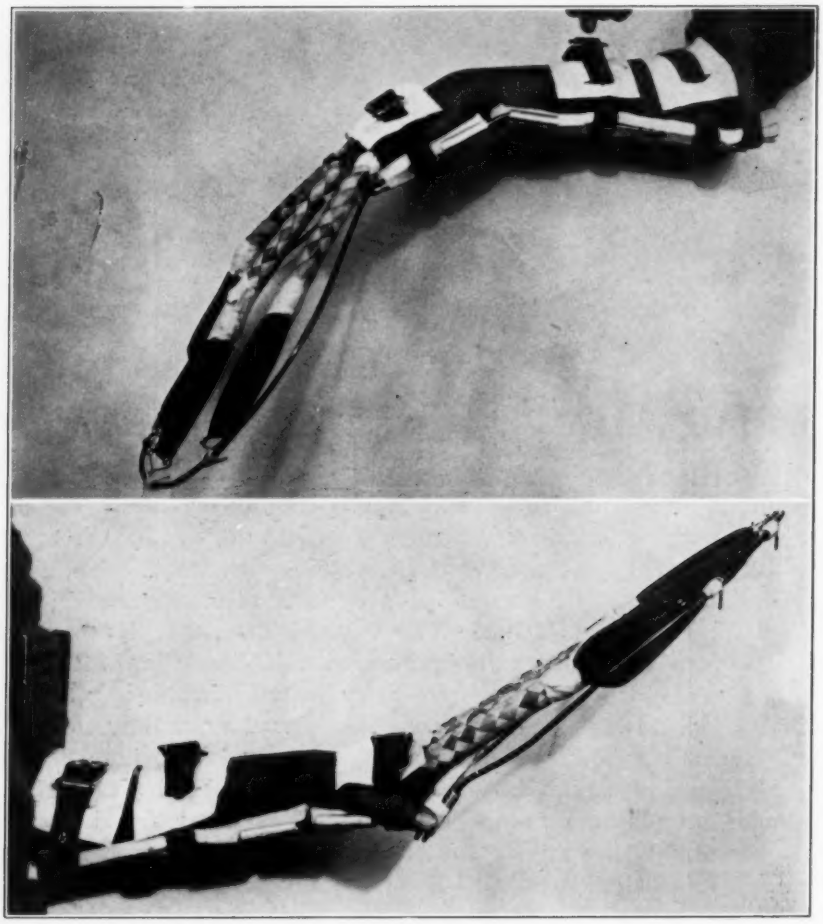

FIG. 3
Splint applied to hand.

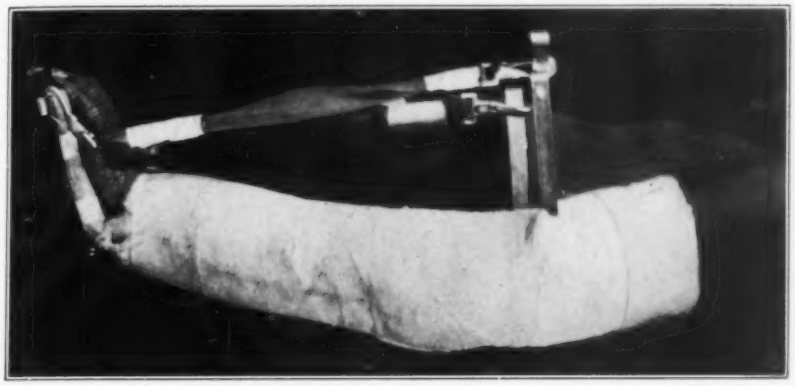

FIG. 4

Straps have been removed from splint, and splint and forearm encased in circular turns of a plaster bandage, traction being continued upon the distal portion of splint exerting dorsiflexion of wrist.

As dorsiflexion improves, the Esmarch is gradually shortened to keep up the tension, which is maintained continuously until complete dorsiflexion of the wrist is accomplished. The wrist is next immobilized in this position by incorporating the distal portion of the splint in the plaster (Fig. 5), and traction renewed on the fingers which by this time have again become flexed. Dorsiflexion of the fingers is then gradually increased until they themselves are in complete dorsiflexion. Forearm, wrist, and hand are then encased in a plaster-of-Paris splint in the corrected position, and so maintained from four to six weeks. No immobilization was used in our first case after complete correction; three weeks later the deformity was found to be almost as bad as before treatment was

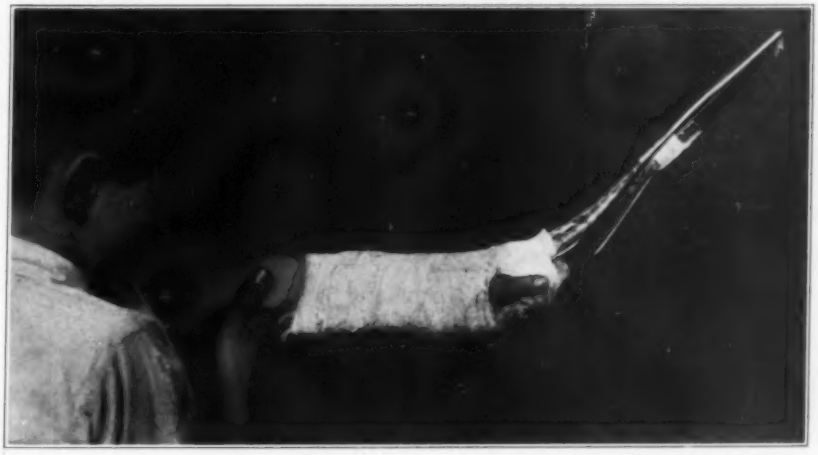

FIG. 5

When complete dorsiflexion of wrist has been obtained, the wrist is immobilized in this position by circular turns of plaster bandage about the distal portion of the splint and hand, and traction is again made on the fingers.

FIG. 6-A
Case 1. X-ray of right forearm on admission.

FIG. 6-B
Result, six months later.

commenced. It is, therefore, of vital importance to always immobilize these cases after their correction.

Experience has shown that the prognosis in these cases, is, to a large degree, dependent on the amount of muscle tissue that is viable and capable of contracting. As a rule, the older the case the more marked the fibrosis; on this basis many authors consider that cases of several months' duration can be benefited only by operation, and that only early cases are amenable to daily massage and muscle stretching.

It is the belief of the writer that all cases can be helped by this

method, no matter how old or how marked the deformity. The deformity can always be corrected, but it is not known how much function will be obtained, as this depends to a large degree on the amount of muscle tissue viable.

Constant, continuous elastic traction, aiming at stretching of this scar tissue, thus overcoming the deformity and leaving unhampered whatever muscle tissue there is viable, is the rationale of this treatment; traction is maintained day and night, the tension being so regulated as to cause little or no pain; in fact, pain and discoloration of the part mean that the tension is too great and should be reduced. It has been found that the results obtained by this method are superior to those achieved by any of the several operative procedures; a remarkable degree of restoration to function is often accomplished in cases that, in the beginning, seemed hopeless.

CASE REPORTS

CASE 1. L. S., boy, eight years old, was admitted to the Hospital September 5, 1930, with a typical claw-hand deformity. There was flexion of the wrist, extension of the metacarpal phalangeal joints, and flexion of the interphalangeal joints. There was some wasting of the muscles of the hand and forearm, but most pronounced atrophy was present at the thenar eminence. The child complained of severe pain on manipulation; no active motion of the hand or fingers was possible. The history was that of a supracondylar fracture of the humerus three months before admission, treated in another hospital in splints with flexion at the elbow for a period of three weeks. This patient was discharged on March 8, 1931, completely cured. It is impossible now to distinguish between the pathological and the good hand.

CASE 2. W. E., boy, eleven years old, was admitted to the Hospital November 23, 1929, with a history of injury to left forearm in August, 1929, due to a fall. Cast had been applied for four weeks in another hospital. Typical deformity was noticed on removal of the cast. Examination showed the right hand held in claw attitude with marked flexion at the second phalangeal joint, extension impossible, and practically no motion of the wrist. Sloughing of the little finger was noticed a few days after admission. Neurological examination showed involvement of the ulnar nerve and neurolysis was attempted a few weeks afterwards with some improvement in sensation over the ulnar distribution. Marked trophic changes subsequently developed in all the other fingers, so that application of the splint had to be delayed until all the sores had healed. This patient was discharged on August 30, 1930, with a hand that was quite useful, extension being complete. His grip was good, and now he can use the hand with almost as much ease as before his injury.

CASE 3. S. M., boy, nine years old. This patient was admitted on March 27, 1928, with a history of a supracondylar fracture four months before admission. He was treated at another hospital for six weeks with plaster-of-Paris molded splints, with the resultant deformity. Examination showed a typical claw-hand deformity, with marked flexion at the wrist and interphalangeal joints; practically no movement at the wrist; slight motion of the fingers. There was marked atrophy of the interosseous muscles of the hand and some atrophy of the muscles of the forearm; sensation was lost over the distribution of the median and part of the ulnar nerve. Trophic changes were present in all the fingers. Roentgenograms showed old supracondylar fracture of the humerus with slight backward displacement of the lower fragment.

This boy was discharged on August 17, 1928, markedly improved. The result in this case is not as good as in some of the others, which fact we attribute to an almost complete destruction of the muscle tissue of the forearm. However, the boy can use his hand

FIG. 7-A
Case 2. Before admission.

FIG. 7-B
After treatment, seven months later.

fairly well. He can write, carry objects, handle a knife and fork, and do almost everything with it, but his grip is very poor.

CASE 4. R. S., boy, eleven years old, was admitted September 30, 1929, with a

FIG. 8-A
Case 3. On admission.

FIG. 8-B
Four years later.

history of having fallen six feet in August, 1929, landing on the left forearm. A dislocation of the right elbow was reduced in another hospital, where it was found that he also had a fracture of the lower end of the radius. A plaster cast was applied to the forearm after reduction, which was not successful. An open reduction was subsequently done and the forearm placed in a cast for five weeks. A typical Volkmann contracture was found on removal of the cast. Examination showed a two-inch scar on dorsum of the

wrist over the radius. There was a large amount of firm callus at the site of the fracture. Wrist was held in acute flexion with typical claw-hand deformity. No active motion was possible, either of wrist or fingers; passive motion of the wrist of about fifteen degrees. Wrist was very painful. No sensory disturbances. Roentgenogram showed an old comminuted fracture of the lower extremity of the radius with backward displacement of the radial epiphysis. This boy was discharged on February 4, 1930, completely cured.

FIG. 9-A

FIG. 9-B

Case 4. FIG. 9-A: On admission. FIG. 9-B: Six months later.

CASE 5. M. D., boy, seven and a half years old, was admitted with a history of a supracondylar fracture of the humerus six weeks previously. He had been treated elsewhere with a plaster cast which was left in place uninspected for five weeks, at the end of which time the typical deformity was found. Examination showed marked flexion of all the fingers, with marked atrophy of extensor and flexor groups of muscles; marked limitation of movement of the wrist and fingers. Roentgenograms showed an old fracture of the lower fourth of the radius and ulnar, with slight backward displacement of the lower fragment. This patient was discharged on November 2, 1931, with a hand that is practically normal.

CASE 6. C. L., boy, eleven years old. Patient was admitted on February 2, 1932, with a history of fracture of the left humerus, lower fourth, one year ago. He was treated for three weeks with plaster-of-Paris splints with elbow at right angle. On removal of splints he was found to have an ankylosed elbow and wrist-drop. Examination showed a left forearm held in flexion at an angle of eighty-five degrees, with practically no motion. Triceps muscle, all of the forearm muscle, and hand muscles were markedly atrophied. There was complete wrist-drop with claw-hand. This boy is still under treatment. Correction of wrist and hand to a more horizontal plane have been accomplished.

FIG. 10-A
Case 5. On admission.

FIG. 10-B
Eight months later.

CASE 7. J. B., female, aged forty-five years. This patient was a private case. She had a Colles' fracture in July, 1928, and was treated by another doctor with plaster-of-Paris molded splints, which were kept on, uninspected, for five weeks. On removing these splints, a typical claw-hand deformity was noticed. When seen by the writer in January, 1929, she showed marked flexion of the wrist and fingers. There was very little movement of the fingers and practically none of the wrist. There was marked atrophy of all the muscles of the hand,—in fact, the hand was quite useless. X-ray showed an old Colles' fracture with marked posterior displacement of the lower fragment. It also showed atrophic changes in all of the carpal bones. She was under treatment for exactly one year, with good functional result.

I am indebted to Dr. Carl G. Burdick and Dr. Fenwick Beekman for permission to report these cases and wish to express my appreciation for their help and encouragement.

WALKING MEMBERS FOR BILATERAL AMPUTATION OF THIGH

BY THOMAS F. WHEELDON, M.D., RICHMOND, VIRGINIA

The writer has had several cases of bilateral amputation of the thigh, just below the trochanters of the femora, for which he has used different types of supports. None seemed entirely efficient until the present type, herewith illustrated, was designed. The material used in the construction of these supports is light, rustless steel, the wearing quality of which has been excellent. The treads are large and firm; and the patient wearing them gets around splendidly with wonderful balance. There has been no difficulty either in getting a patient to wear this apparatus or in teaching him how to do so, and, as it places the wearer close to the ground, there is very little fear of falling. After the patient gets used to this length of support a taller one can be used without difficulty, if for any reason such is desirable.

FIG. 1

FIG. 2

A SPLINT FOR FRACTURES OF THE LEG

BY HARVEY C. MASLAND, M.D., PHILADELPHIA, PENNSYLVANIA

The illustrations present a splint construction for the reduction of a fracture of the leg, more particularly for the upper third. For the lower two thirds of the leg, an unpadded plaster cast, extending from the fulness of the calf muscles over the flexed knee and well up on the thigh, is substituted for the upper portion of this splint.

The buttock ring is of two metal, semi-elliptical strips properly prepared for adjustable connection with each other. The ring is fitted to rest snugly upon the skin surface throughout its circumference. It bears upon the ilium, the ischium, and the pubic bone. It is covered with felt over which an artificial leather bandage is applied tightly and smoothly. This is anointed with some emollient ointment, such as cold cream.

The thigh splint arms, in two pieces on each side of the limb, are adjusted to the length of the femur. Their upper ends are angulated to give the correct tilt to the buttock ring. They are attached to the ring before the felt is applied.

Two metal strips are bent to form an adjustable stirrup which is encased in the slipper plaster cast. The ends of this stirrup flare out over the malleoli. The leg splint arms, also in two pieces, are attached to the slipper cast and to the thigh splint arms in the axes of the respective joints. An aluminum gutter splint, of ample proportions, is laid along the posterior length of the femur, and held tightly to the splint arms with adhesive plaster. A brace, spanning the knee joint, locks the joint against movement in the subsequent distention.

For the distention, a turnbuckle assembly is attached to the overlapping leg splint arms. With the immediate reduction of a fresh fracture, complete correction of the overlap can be expected as routine. A gutter splint, or splints, is applied to the fracture, both for support and for the correction of any tendency to lateral deviation.

The splint equipment here illustrated is very simple. The pieces are selected from a portable outfit which is complete for the splinting and reduction of a fracture of any bone of either limb. In this equipment there is an assortment of four different lengths of metal splint arms, and three different lengths for construction of the rings for the shoulder, the buttock, and a clavicle-chest ring. There are a few brackets, sleeves, etc. for general purposes and some special pieces for the patella, the olecranon, the carpal, tarsal, metatarsal, and metacarpal bones; also a device permitting rotation of the forearm within the splint. The instruments comprise a pair of special bending wrenches, plaster instruments, and some miscellaneous tools purchased in the hardware store.

The plan of assembling the splint pieces and the mechanical principles involved are clearly shown by the illustrations. In the fracture of any long bone of either limb, the principle of securing a safe, well dis-

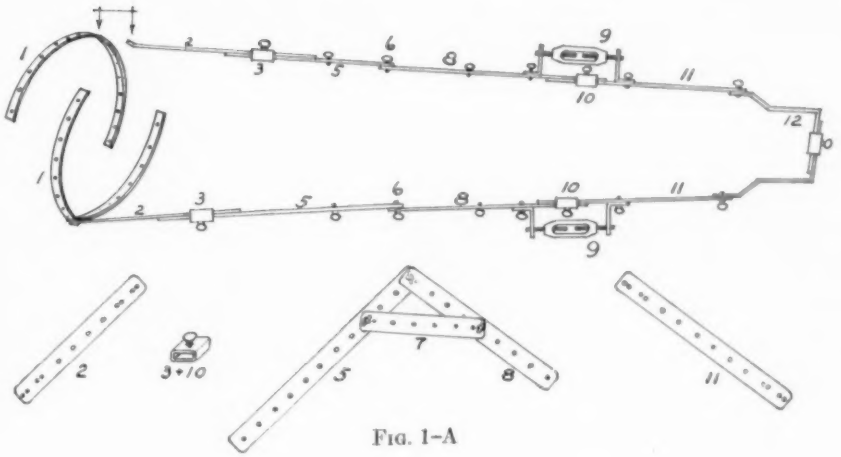

FIG. 1–A

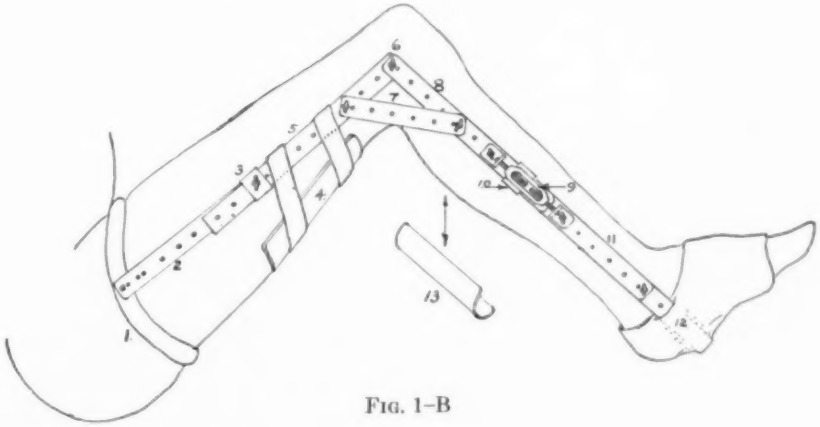

FIG. 1–B

Similar numbers indicate similar parts.

1. Adjustable buttock ring.
3. Clamping sleeve enclosing *2* and *5*, the overlapping thigh splint arms.
6. Pivoted joint at the knee.
10. Clamping sleeve enclosing and holding the leg splint arms in any degree of distention.
9. The turnbuckle assembly for the distention.
2. Adjustable foot stirrup encased in the plaster slipper cast.
7. A temporary knee-joint fixation brace.
13. A supporting splint for the fracture.
4. Pressure gutter splint against the femur.

tributed, and sufficient support upon adjacent skeletal structures is followed. As the splint has stabilized the bone, the subsequent distention produces a smooth sliding backward of the displaced bone into normal position. There is no pain and only in some complicated cases is there need for an anaesthetic.

Subsequent adjustment of the splint is very simple. The splint design permits immediate or very early function of the adjacent joints, without disturbance of the immobilization of the fracture.

AN APPARATUS FOR EXERCISING PARALYTIC LIMBS

BY JAMES C. WILSON, M.D., HARTFORD, CONNECTICUT

During the epidemic of 1930, at the Municipal Hospital at Hartford, Connecticut, we had fifty-two cases pass through the Orthopaedic Ward, which were in need of treatment calling for underwater exercise. At the Hospital there was installed a very satisfactory tank, but to exercise the twenty or more patients at frequent enough intervals was impossible, due to lack of time.

Notwithstanding the opinion of some men that a long rest period is necessary before starting exercises, the author can see no reason for delaying the exercises after the period of irritability is passed. Prevention of contraction, preservation of nutrition and general condition demand exercise, and no other method can take the place of attempted voluntary motion. In motion there are two distinct impulses given, one for contraction of the intended muscle, and one for the relief of tension in the opposing muscle. Only by attempted voluntary motion do these two impulses coordinate and tend to give the balance of power needed about the joint.

In view of the fact that limbs that could not otherwise move might show some impulse when raised from the bed, we made use of some bars passing through the ward, over the beds. By suspending a limb by means

FIG. 1

Leg in sling to exercise hip and knee group. Patient too weak to move limb when on back but does very well when on side.

FIG. 2

Showing arm in sling to exercise abductor and adductor groups at shoulder.

of a muslin bandage it was possible to relieve the limb from the force of gravity, as in the tank, and a very good type of exercise could be given. In fact, there was no motion which could not be carried out, except that involving the back, providing there was any power left.

The position in which the exercise may be given to the best advantage depends somewhat upon the operator. Flexors of the thigh, for instance, when too weak to draw up the knee may be exercised at the

FIG. 3

beginning with the patient on his side. Arms and hands may be suspended in the sling with the patient either sitting or lying. Every motion possible to attain in the tank may be duplicated in the sling. The sling has these advantages over the tank:

1. Frequency of exercise (sometimes as much as three or four times a day), always approaching fatigue but never reaching it.
2. The example to smaller children of the older patients who can understand just what we want them to do; the smaller children eventually accept the exercise as a game.
3. The possibility of exercising any number of patients at the same time without removing them from their beds.
4. The possibility of its use in the private home where it is a cheap, simple, and very efficient piece of apparatus.

FIG. 4

Result after two months of treatment for severe back-knee.

The degree of atrophy in the limbs so treated was much less marked than seen in the patients who came into the clinic and who had not been so treated. Braces for the prevention of deformity during this intermediate stage of the disease were less frequently needed, relieving the limb of any constricting bands or bandages which can only restrict circulation. Of course, these cases were kept under close observation for such deformity as might occur, and, in case the limb could not be easily held in the normal position after it had been out of the sling for twelve hours, braces were applied.

As to the apparatus: It is simply a gauze bandage or other sling placed over a bar or hook above the bed. For a bar, a Balkan frame or curtain pole may be used, or a heavy hook or ring placed in the ceiling over the bed will serve the purpose. This apparatus has also been used to advantage to free up shoulders after fracture, and in other conditions where voluntary effort has been desired to increase motion.

The tank has been the means of starting many patients who otherwise would have been considered totally paralyzed; but there are many places where the tank is not available on account of the location of the patient or the overcrowding of the wards, and, in the author's experience, the sling not only does everything the tank can do, but may be used anywhere with considerably less trouble.

AN ORTHOPAEDIC AND FRACTURE TABLE EMBODYING NEW PRINCIPLES

BY WILLIAM LISLE BELL, M.D., OAKLAND, CALIFORNIA

The table illustrated is supplied with a solid sacral support which is rarely, if ever, used, once the operator becomes familiar with the soft, fiddle-string tight, double-layer, longitudinal, canvas support, split at its foot end for the introduction of a padded saddle.

Figure 2 shows angled top view of this tight supporting canvas when properly placed.

Figure 1 gives one view of foot piece, and method of positively bandaging foot to foot piece. This mechanism permits any angle of rotation or ankle flexion, and locks positively in any position.

Figure 3 illustrates sliding extension spars capable of use throughout the full length of the table. These spars apply traction at any angle to either legs or arms.

Figure 4 pictures padded axillary hooks, useful for spinal distractions with patient prone or supine, and for lessening perineal pressure against saddle during leg or hip traction.

Figure 6 shows foot piece with patient prone (fully as efficient). Note straight body line with tightly drawn canvas.

Figure 5 shows the canvas relaxed. This may be done gradually, and locked anywhere instantly. Proper support is provided with one of the cross tables under the knees. Extreme posterior concavity is readily obtainable by this method.

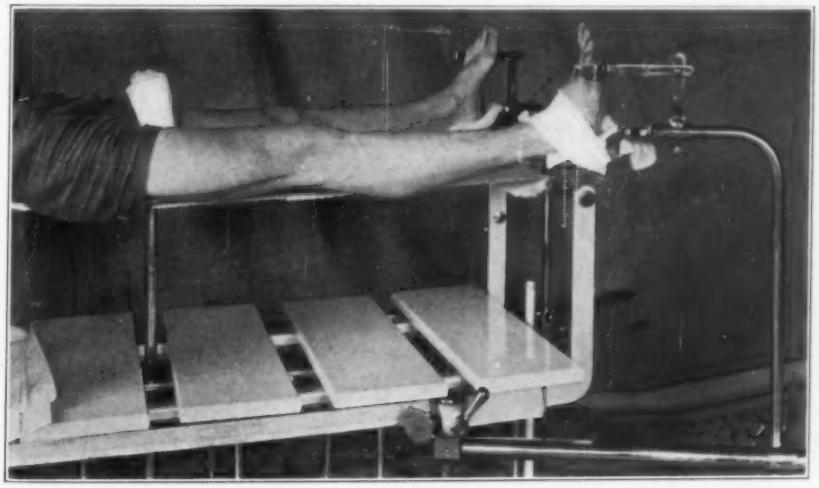

FIG. 1

Foot is shown bandaged obliquely, with bandage engaged in tooth on bottom of foot pan. Saddle and stud are in place. Padded plantar plate at base of toes maintains any degree of dorsal flexion or rotation.

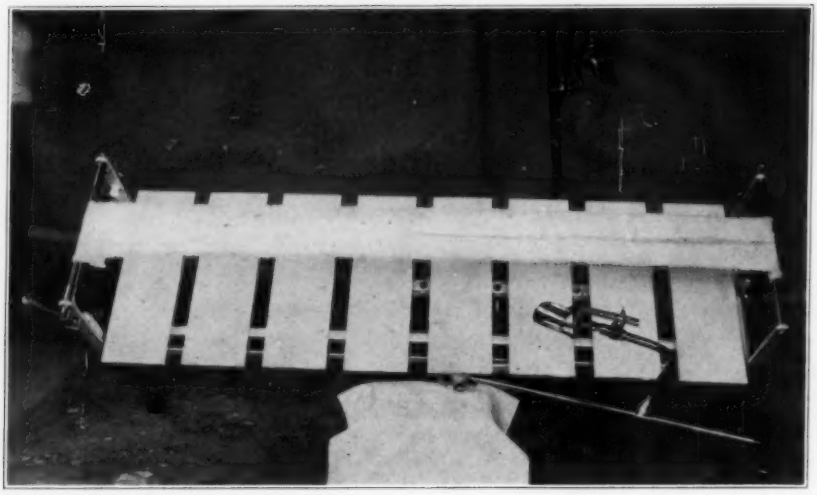

FIG. 2

Canvas shown is wider than needed. There are three holes for saddle stud under cross tables. Powerful, split, accurately adjustable windlasses wind canvas over top. Note slit in canvas to permit introduction of saddle stud.

Figure 7 illustrates the method of application of Böhler's os calcis traction, and application of plaster case without extra equipment. Patient rests on all cross tables lowered to frame during this operation.

All cross tables are raised and covered with sterile blanket when

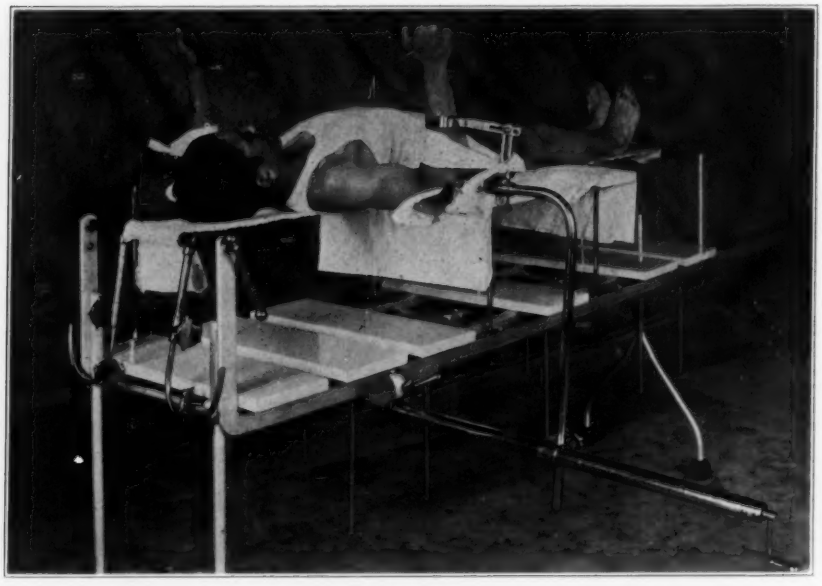

FIG. 3

Leg spars moved up to shoulders. Shows arms in traction, at right angles to body axis. Rotation is controlled. Still greater abduction is possible if needed. Fully accessible for plaster.

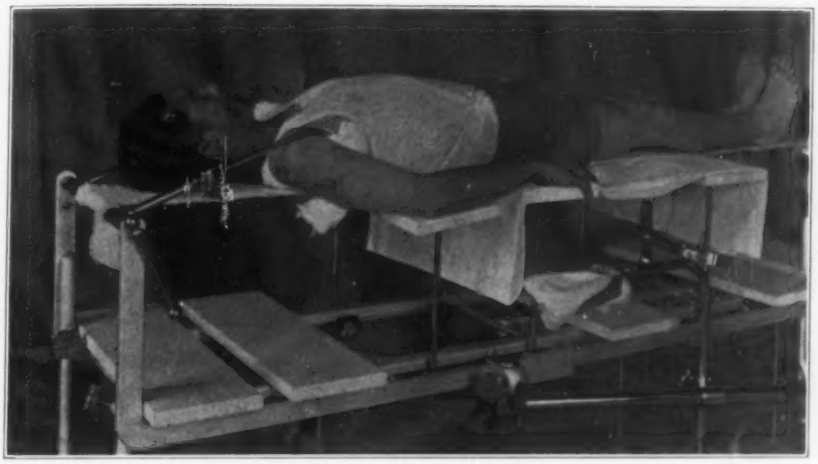

FIG. 4

Adjustable axillary hooks, padded, divide and lessen perineal pressure and permit spinal traction when perineal post is removed. Few cross tables are elevated. Feet should be bandaged in foot pieces.

patient is placed on canvas. After this the necessary number of cross tables are instantly lowered singly, or in any combination desired. This lowering is accomplished with ease from either side, or both sides of the table. Patient rests at all times on soft, non-bruising, non-metallic support, fully accessible for plaster-of-Paris throughout full length, base of the neck to heels. The canvas is ignored throughout operation, after which it may be cut and removed. The patient may remain supported upon this canvas without sacral or perineal injury until the plaster case is safely set. This makes for lighter plaster encasement. With fractured

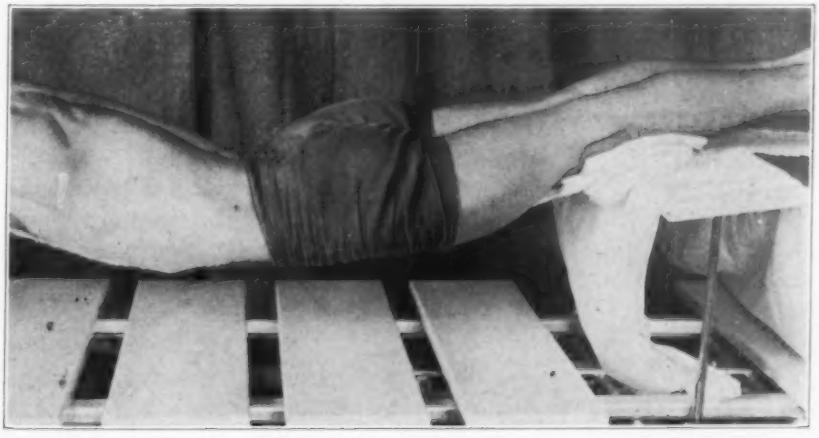

FIG. 5

Shows use when posterior spinal concavity is indicated. Proper support above the knees is provided. This represents about half the curvature obtainable by this method.

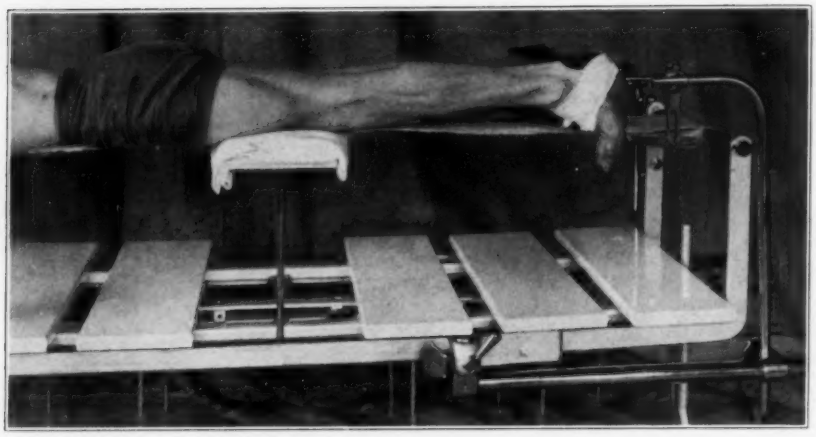

FIG. 6

Shows patient prone and one cross table elevated. Foot piece is equally efficient with toes downward and is positively lockable at any angle.

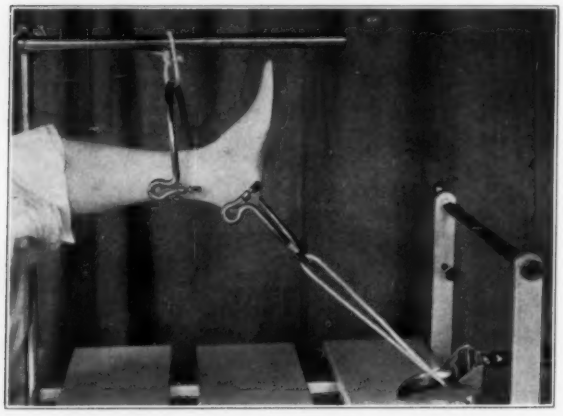

FIG. 7

Quick acting saddle support device for Böhler os calcis traction. Foot pan may be instantly adjusted at any angle for traction. Various types of nails or stirrups may be used.

hips, it is quite possible in many cases, to reduce and encase without general or local anaesthetic. Only the hypodermic is used, resulting in less shock, gentler manipulation, very accurate control, no sacral injury.

This table possesses removable, lockable legs; is light and very strong; occupies but two square feet on its end when not in use; takes the place of several tables, a number of pieces of traction and manipulation apparatus; is completely housed from plaster drip; has full-length traction for arms, as well as legs, and at all possible angles. The table may be used for the treatment of any patient, from an infant to an adult seven feet in height.

One or both feet may be encased in light plaster boots preceding traction, and rested in foot pans during manipulation. These plaster-of-Paris boots may be firmly anchored to vertical studs of foot pieces. When the attachments to foot pans are cut, after splinting is completed, the foot is held in accurate position by the foot pan. In other words, the foot does not drop.

This table embodies in one unit of equipment clinical control of a

very wide range of fracture requirements. It has been tested clinically and mechanically through various models for twelve years.

The idea of a longitudinal canvas support came to most of us through a frame given us by Dr. E. H. Bradford. This particular use, however, so far as the author is aware, has not been applied to orthopaedic tables. It must be remembered that this canvas is split, is in combination with the saddle, permits traction and full accessibility of the patient, and must of necessity be an integral part of a device solely designed to meet all these requirements. The avoidance of sacral pressure in heavy, elderly patients is no small consideration.

This device was shown by the author at the meeting of the American Medical Association in 1926. Since that time a certain number of refinements have been added.

EPIPHYSITIS OF THE PROXIMAL OR PSEUDOMETATARSAL EPIPHYSES OF THE FOOT

Report of a Case*

BY M. S. BURMAN, M.D., NEW YORK, N. Y.

Epiphyses are present occasionally at the bases of the metatarsal bones, and Sawtell [1] notes that similar epiphyses may exist in the hand coincidentally. Irregularity in the formation of the bones of the foot is not noted after the age of five years and six months. These accessory or "pseudo-epiphyses", as they are termed by anatomists, have no particular significance. Sawtell believes them inherited; others regard them as due to an endocrine disturbance. Köhler [3] points out that these proximal epiphyses are always present in man in the primitive formation, but that fusion takes place early with the ossifying diaphysis.

It was noted previously [2] that no case of disease of the pseudo-epiphyses had ever been reported. We are reporting now a case of bilateral disease of the second and third proximal epiphyses of the foot, the findings being interpreted as an epiphysitis.

Case D551. A boy, three and a half years old, was seen in the Out-Patient Department of the Hospital for Joint Diseases on January 12, 1932, because of pain of a year's duration, in both forefeet. There was no previous illness and no history of injury. Pain was greater in the left foot. Both feet showed moderate valgus with adduction of the forefeet. Motions of the feet were free and painless. No tenderness was present over the bases of the metatarsals and only slight tenderness beneath their heads.

FIG. 1

Roentgenograms of both feet were taken and revealed these interesting changes.

Proximal or pseudo-metatarsal epiphyses were noted at the bases of the second, third, and fourth metatarsals, bilaterally. The epiphysis of the base of the

* From the Service of Dr. Leo Mayer, the Hospital for Joint Diseases, New York.

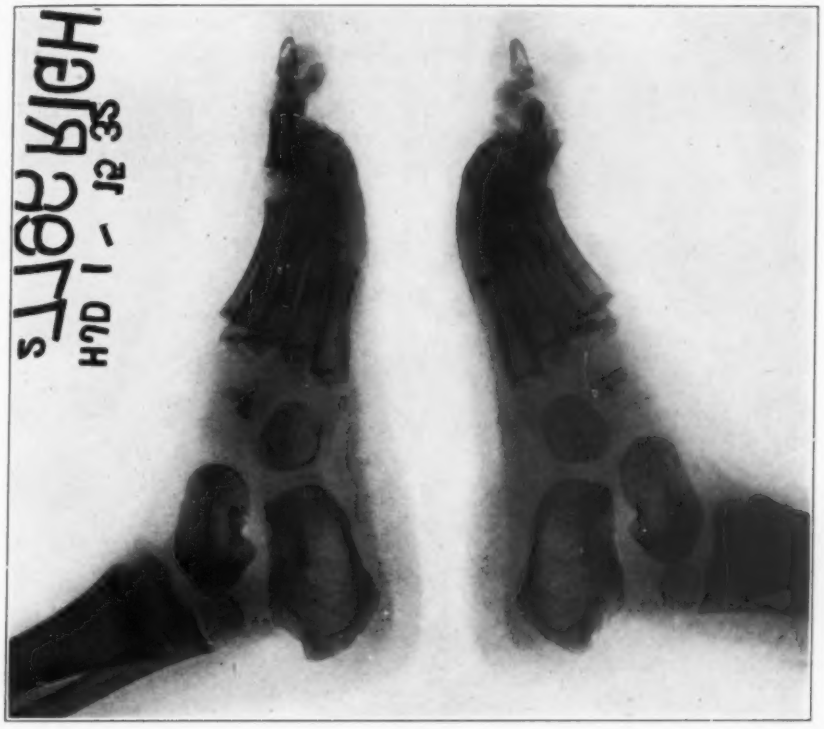

FIG. 2

fourth metatarsal was well developed and normal on both sides. No proximal epiphyses were seen in connection with the fifth metatarsals. The accessory epiphyses over the second and third metatarsals were indistinct, swollen, fragmented, and showed indefinite areas of rarefaction and condensation. These changes were best seen in the proximal epiphysis of the second metatarsal, better on the right side. The normal distal epiphyses of the metatarsals were well seen at the head of the second metatarsal bone on both sides. The third, fourth, and fifth metatarsal heads on the right foot did not show distal epiphyses. The third and fourth left metatarsal heads presented indistinct distal epiphyses.

The proximal epiphysis of the first phalanx of the great toe appeared slightly compressed anteroposteriorly and possibly denser than normal, on both sides. It is doubtful if this epiphysis is the seat of an aseptic necrosis. The centers of ossification of the navicular bones were not present and the cuneiform bones showed beginning ossification. Greatest ossification was present in the external cuneiform of the right foot, which showed two areas of increased density in its substance.

The patient was seen only twice and could not be located for further examination.

This change is most probably of a self-limited nature, and, if x-ray examination is carried out after the age of five and a half years, it will probably have cleared up, since this is the upper age limit of irregularities of ossification in the feet of normal children. Its roentgenographic features correspond to those usually attributed to epiphysitis. Again, this is an unusual location for epiphysitis.

May I express my thanks to Dr. M. Pomeranz for his aid and criticism of this paper.

REFERENCES

1. Sawtell, R. O.: Irregular Ossification of the Extremities of Boys and Girls. Am. J. Roentgenol., XXV, 330, 1931.
2. Burman, M. S., and Pomeranz, M.: Epiphysitis of the Proximal Epiphysis of the First Metatarsal and of the First Phalanx of the Big Toe; Coincidental Presence of Proximal or Pseudometatarsal Epiphyses. J. Bone and Joint Surg., XIV, 177, Jan. 1932.
3. Köhler, Alban: Röntgenology: The Borderlands of the Normal and Early Pathological in the Skiagram. Translated by Arthur Turnbull. New York, William Wood and Co., 1928.

SIR ROBERT JONES

SIR ROBERT JONES, BT. K.B.E., C.B., F.R.C.S.

The kindly word, the cheering smile, the twinkling eye, the whole magnetic personality of Sir Robert Jones remains only as a memory. The world's greatest orthopaedic surgeon has completed his life's work; quietly as he was born seventy-four years ago at Rhyl on the North Wales coast, just as quietly he died in the early days of this year at a little village in Montgomeryshire.

In an appreciation of the life of a great man it is customary to refer to the loss the world has sustained in his death. But by his very greatness Sir Robert Jones has mini-

mized this loss; as long as Orthopaedic Surgery lives, so long lives his spirit. He it was who allied the pioneer work of his uncle, Hugh Owen Thomas, with the principles of modern aseptic technique, who differentiated the surgery of the spine and limbs from other branches of Medicine, who fought for the recognition of Orthopaedic Surgery, who with infinite tact and perseverance struggled to establish it on a firm foundation, and who had the satisfaction during his lifetime of observing the progress and the development of his offspring. He whose work cannot die, whose influence lives on after him, whose disciples can perpetuate and multiply his gifts to humanity, is truly immortal.

Hugh Owen Thomas was the descendant of many generations of unqualified bone-setters who had practised in the hills of Wales. Hereditary skill and dexterity were coupled with academic training and enriched with the products of an original and fertile mind. His patients were drawn not only from the industrial centers of Liverpool but from far beyond the boundaries of his own country, to the house in Nelson Street which is now world famous. Here it was that Robert Jones served his early apprenticeship and learned principles of treatment which frequently were uncompromisingly antagonistic to the accepted teachings of the day. Here he continued to work throughout his life, and in the same small cubicles he was still seeing patients until within a few weeks of his death.

He qualified in 1878 and obtained the F.R.C.S. Ed. in 1889. As a very young man, he was appointed General Surgeon to the Liverpool Stanley Hospital, and when thirty years of age continued general surgery at the Royal Southern Hospital. Ultimately he confined his activities to orthopaedic surgery and with abounding energy and unquenchable zeal he would complete twenty or more operations in an afternoon. He was visited by surgeons from all over the world, not only at the Southern Hospital but at his free Sunday clinics at Nelson Street. The majority of visitors, like the Mayo brothers in their earliest European tour, intended staying for a day, but found themselves magnetized for a week. He influenced the development of orthopaedic surgery not only through his visitors but through his patients, and many have themselves become distinguished in the annals of orthopaedics. His early association with Dame Agnes Hunt led to the development of a hospital first at Baschurch and later at Gobowen, which has since organized the treatment of cripples over a hundred miles' radius and has proved the forerunner of the orthopaedic after-care clinics established throughout England and Wales. Any attempt to enumerate his hospital appointments—Heswall, Chailey, St. Vincent's, Llangwyffan, St. Thomas', Shepherd's Bush, Roehampton, and so on—simply points to the fact that there has been no orthopaedic center in England which has not been served by him.

Behind his genial, smiling countenance and apparent simplicity, Robert Jones possessed the keenest brain, the most brilliant organizing ability, and the tact, the patience, the perseverance and the astuteness of a diplomat. Never was man faced with greater difficulty or with more serious opposition than he was in the early days of the War, when he was entrusted with the establishment of the first military orthopaedic service of this or any other country. He was appointed to the war office as Director of Orthopaedics with the rank of Hon. Major General. England's home service began with 200 beds at Alder Hey in Liverpool; but within a short time the help of many English and American surgeons was enlisted, and 33,000 beds were equipped and staffed with trained orthopaedic surgeons. The brain which had already solved the problems of the cripple in civil life readily adapted itself to the problems of war. Incredible as it may be, the gigantic task was accomplished and a complete service established from first aid treatment in the field to the last stages of re-education and after-care. In 1918 he continued and completed his military orthopaedic work through his appointment as Hon. Consultant to the Ministry of Pensions. In recognition of his war services, His Majesty conferred upon him the C.B. and later a knighthood, and the United States Army awarded him the Distinguished Service Medal.

The academic world found it difficult to pay adequate tribute and honor to the name of Sir Robert Jones. There appears to be no important orthopaedic congress over which he has not at one time presided. Having already been the first president of the Interna-

tional Orthopaedic Society, this body expressed its almost inarticulate admiration by appointing him Permanent President. Similarly he was Emeritus President of the British Orthopaedic Association. He was the recipient of honorary degrees of the Universities of Liverpool, Aberdeen, Wales, Yale, Harvard, and Smith College. Honorary fellowships were conferred upon him by American, French, German, and Italian bodies.

Eulogy and laudation were as nothing to Sir Robert when compared with the friendship of his fellow men. He was a most accomplished raconteur but invariably the story was a true one. His sense of humor was of the most vivid type, his memory surprisingly retentive, and nothing pleased him more than to tell a story against himself. Hour after hour he would recall how he had been routed from a tenement house by an irate parent, how in a royal palace he had made a frustrated effort to wash his hands and disturbed a prince in his bath, how travelling in a train and troubled with a painful knee he had been advised to consult a rather good bone-setter in Liverpool by the name of Robert Jones. He was widely read and in his early days founded a literary society in Liverpool. Among his friends he numbered many distinguished authors and artists, as well as lawyers, politicians, judges and actors. He was keenly interested in cricket, an expert boxer, an authority on pedigreed dogs, and deeply attached to his St. Bernard and Alsatian. Above all was his love for children who rapidly learned to trust him. He spoke ill of no man, and was utterly incapable of meanness, sarcasm, or unjust criticism. Calm, unruffled, and restrained, his displeasure was felt rather than heard and was the more effective for its rarity.

Throughout his career he practised in Liverpool, and Liverpool has paid its last and greatest tribute to the honor of one of its citizens. The ashes of Sir Robert Jones are the first to find a resting place within the walls of the Cathedral. The urn stands on a column of stone, close to the foundation pillar, beneath the stained glass window dedicated to "Service". As long as the walls of that vast cathedral stand, they will shelter all that has died of Robert Jones, as a token and a memorial of his service to mankind. In the hearts and minds of those who came within the glow of his presence and who learned humbly to love him, his spirit still lives.

ANSEL G. COOK

ANSEL GRANVILLE COOK

Ansel Granville Cook, son of Captain William and Harriet (Bliss) Cook, was born in Scotland on April 18, 1862, at a time when his father was United States Consul to Scotland. He died suddenly of heart disease at his home, 722 Asylum Avenue, Hartford, Connecticut, on January 25, 1933.

Dr. Cook was graduated from the College of Physicians and Surgeons of Columbia University, New York, in 1887, and followed continuously his profession as orthopaedic surgeon in Hartford, Connecticut. He was Orthopaedic Surgeon, and also Consulting

Surgeon, to the Hartford Hospital, and Consulting Surgeon to several other important hospitals in the State. He was a Charter Member of the American Orthopaedic Association and served as President in 1909, and was always present at the meetings of the Association. In 1926, the honorary degree of Doctor of Science was conferred on him by Trinity College. He was elected an Honorary Member of the American Academy of Orthopaedic Surgeons, which was organized in January 1933.

He had many and wide interests and his mind was fertile, and he was constantly occupied in initiating new methods and designing mechanical means of treatment. His capacity to think along fundamental lines, to think clearly, logically, courageously, and honestly, coupled with his great ingenuity and resourcefulness, naturally led him to conclusions of importance in the rapidly changing medical world in which he lived. Especially should his work on the foot and the shoes and his exhaustive study of what he called "Question of Balance" have special mention. They were both original and practical. His article on "Tuberculosis" and "The Mind Cure" clearly shows his broad grasp of psychology years before the subject was a household word. His practical plan for the treatment of rickets long before vitamins were known, cannot be improved upon today since it embodied the principles of rest, sunshine, fresh air, and natural clean milk which was not to be "sterilized, pasteurized, nor devitalized" in any way.

Dr. Cook was among the first of the orthopaedic surgeons of the Medical Reserve Corps to ask for service in 1917. He said to the Director of the Orthopaedic Service in the Surgeon General's Office: "I have closed my office, and told my patients that I will not be back until the War is over. I ask for immediate service." He served as Major and for a short time was stationed at Fort Adams, Newport, Rhode Island, and then sent as instructor and inspector to a group of army posts in the eastern part of the South, and from there to Fort Sam Houston, Texas, where he remained until the end of the War. He gave throughout generously not only of his skill, but also of his unusual personality.

From a letter signed "E. C." from Santa Barbara, California, published in the Hartford Daily Courant of February 3, 1933, the following is taken:

"We shall miss his presence among us, the brave gentle soul who met life with such valiant courage. I think of him in so many ways: the great surgeon with the gift of healing and restoring in his sensitive fingers; the friend whose joy it was to do kind things for people; the lover of birds and animals and all the beneficent, wise ways of nature; the affectionate father whose greatest joy was the happiness and success of his children; the inventor who loved to create things with mind and hands.

"I recall the quaint, original humor that was so uniquely his own, and the child-like quality of his nature, which was almost too sensitive for the thorns of this world, the absolute sincerity and simplicity of his soul, and the heroism with which he bore great physical pain.

"I am sure that many homes are happier today because he lived, for to him it was given to make the lame walk, to straighten the crippled body. In his modest, unassuming way he often said, 'I have done the best I could. If I had known better, I would have done better.' He followed the light as he saw it."

He was a loved member of the American Orthopaedic Association, and no annual banquet was ever quite perfect without an after-dinner speech by him. He was a shy man, and droll; proud of his children, and considerate. A close friend paid him tribute when he said, "He and Robert Jones were the two most lovable men I have ever known."

ROBERT SOUTTER

ROBERT SOUTTER

Dr. Robert Soutter died very suddenly in Boston on February 21, 1933, as the result of an infection incurred during an operation. His sudden death in the prime of his prominence as an orthopaedic surgeon leaves a place which is difficult to fill.

Dr. Soutter was born in Kingston, New York, October 4, 1870. His antecedents for several generations belonged to the South. His early and impressionable years were spent in France where he obtained a lasting interest in the French people and the French customs and a thorough knowledge of the French language. Thus, he was in later life

able to be a charming and interesting host to all our French visitors, among whom he had many loyal friends.

He was graduated from Harvard Medical School in 1898 and served as an interne at the Boston City Hospital and at the Children's Hospital, in both of which hospitals he left an enviable reputation for his gentleness and loyalty and the meticulous care which he showed always in later life in all his dealings.

Dr. Soutter identified himself from the beginning with orthopaedic surgery which he practised during his entire career and served in his professional capacity in many institutions, among which were the Boston Dispensary, the House of the Good Samaritan, and the Peabody Home for Crippled Children. For thirty years he was Orthopaedic Surgeon to the Children's Hospital and a member of the orthopaedic teaching staff of Harvard University. He was a member of the Board of Trustees of the Massachusetts Hospital School for Crippled Children at Canton, and was also connected with the Long Island Hospital as Chairman of the Executive Board, and rendered great service in making this institution one of the best of its kind in America.

He was a member of the American Orthopaedic Association and was Vice-President of the Association at the time of his death. He was also a member of the Interurban Orthopaedic Society in which he was particularly interested and whose members he numbered among his closest friends; also a Fellow of the Société des Chirurgiens de Paris and a member of the International Orthopaedic Society.

Starting his career in the early days of orthopaedic surgery, he used the opportunities which were presented to the full and made valuable contributions toward the enrichment of his chosen specialty. He contributed many articles dealing with the problems of orthopaedic surgery, particularly congenital dislocation of the hip, and was the author of a volume of orthopaedic surgery. Carefulness and good judgment marked his work in the surgical field, and the results of his operations testified to these qualities.

Aside from his ability as a surgeon, he understood the practice of medicine as few others. His singleness of purpose and deep devotion to his family and profession marked his whole life. He was always tactful, patient, thorough, and sympathetic. Naturally retiring and sensitive, he was always thoughtful and careful of the feelings of others. He was indeed a great physician and a true gentleman.

Robert Louis Stevenson came very near to Dr. Soutter when he said, "Generosity he has, such as is possible to those who practice an art, never to those who drive a trade; discretion, tested by a hundred secrets; tact, tried in a thousand embarrassments; and what are more important, Heraclean cheerfulness and courage. So it is that he brings air and cheer into the sickroom, and often enough, though not so often as he wishes, brings healing."

News Notes

Just as *The Journal* goes to press, word has been received of the sudden death on March 22 of Edward A. Rich, M.D., of Tacoma, Washington. Dr. Rich was always interested in *The Journal* and, since 1926, had served as a member of its Advisory Editorial Staff.

The Forty-Seventh Annual Meeting of the American Orthopaedic Association will be held in Washington on May 8, 9, 10, and 11, as a part of the American Congress of Physicians and Surgeons. The headquarters of the American Orthopaedic Association will be the Mayflower Hotel. The scientific sessions and clinical presentations will be held at the Walter Reed Medical Center, and transportation will be provided from the Hotel to the Center.

There will be a general meeting of the American Congress of Physicians and Surgeons on Tuesday afternoon, May 9, and the President of the Congress will hold a reception on the evening of Wednesday, May 10.

The tentative program for the Meeting of the American Orthopaedic Association, as prepared by the Program Committee, is as follows:

MONDAY, MAY 8

Morning Session

Roentgenographic Studies of Parathyroid Deossification (slides)	Major J. J. Moore, Washington
End Results of Reconstruction Operation in the Hip (slides and patients)	F. M. Hand, M.D., Washington
The Treatment of Fractures Involving Joints (slides and patients)	Major H. W. Kinderman, Washington
Melorheostosis Leri: Report of Case (slides)	Major J. J. Moore, Washington
The Tunnel Skin Graft as Applied to Orthopaedic Surgery (slides)	Colonel W. L. Keller, Washington
Operative Correction for Non-Union and Mal-Union (slides and patients)	Major N. T. Kirk, Washington
End Results of Fractures of Neck of the Femur (slides and patients)	G. W. Leadbetter, M.D., Washington
Exhibit of Bone Tumors, Gross, Microscopic and X-Ray	Major R. O. Dart, Washington Major V. H. Cornell, Washington
Exhibit of Army Methods of Splinting Fractures of Long Bones for Transportation	Major H. W. Kinderman, Washington

Luncheon—Walter Reed General Hospital

Afternoon

Inspection of Departments, Walter Reed General Hospital
Golf, Army and Navy Country Club

Evening

President's reception to members by Dr. Steindler and Mrs. Steindler

TUESDAY, MAY 9

Morning Session

Chronic Osteomyelitis Presenting Distinct Tumor Formation Simulating Clinically True Osteogenic Sarcoma (slides)	George R. Elliott, M.D., New York
Backache	Joel E. Goldthwait, M.D., Boston
Dupuytren's Contracture (slides)	Henry W. Meyerding, M.D., Rochester, Minn.
Simple Method of Treatment on Many Metatarsal Disabilities (slides)	J. T. Rugh, M.D., Philadelphia
Sciatic and Sacro-Iliac Disease	Albert Freiberg, M.D., Cincinnati
Prespondylolisthesis: Its Roentgenographic Appearance and Clinical Significance	S. Kleinberg, M.D., New York
Acute and Chronic Forms of Bursitis (drawings to illustrate)	Charles E. Sevier, M.D., Denver
Association Business Meeting	
Luncheon, Walter Reed General Hospital	

Afternoon

General Assembly American Congress of Physicians

Evening

Annual Banquet of the American Orthopaedic Association—Mayflower Hotel

WEDNESDAY, MAY 10

Morning Session

Is There a Rational Treatment of Polyarthritis?	P. W. Nathan, M.D., New York
A New Operation for Recurrent Dislocation of the Jaw	Leo Mayer, M.D., New York
Chronic Synovitis of the Knee with Persistent or Recurring Effusion, and of Undetermined Etiology	A. Bruce Gill, M.D., Philadelphia Theodore E. Orr, M.D., Philadelphia
The Treatment of Acute Purulent Arthritis by Joint Washing and Closure	Hugh T. Jones, M.D., Los Angeles
Surgery of Painful Arthritis of the Hip in the Elderly (slides)	M. S. Henderson, M.D., Rochester, Minn.
Fusion of Tuberculous Hips	R. I. Harris, M.B., Toronto
Original Features in Arthroplasty to Mobilize Joints	Fred H. Albee, M.D., New York
Report on End Results of the Tuberculous Joint	Z. B. Adams, M.D., Boston
Luncheon	

Afternoon Session

Presidential Address	Arthur Steindler, M.D., Iowa City
The Relation of Blood Chemistry to the Locomotor System	Russell M. Wilder, M.D., Rochester, Minn.
Block Osteotomy for Bowed Femur	Edwin W. Ryerson, M.D., Chicago
Tendon Transplantations in the Upper Extremity in Cases of Poliomyelitis	Frank R. Ober, M.D., Boston
Mechanical Instability of the Shoulder Joint: In Relation to Prevention and Treatment of Painful Shoulders	Lloyd T. Brown, M.D., Boston John J. Kuhns, M.D., Boston

Description of Operative Procedure for Improvement of Cases with Quadriceps Paralysis	C. C. Yount, M.D., Philadelphia
Pelvic Relaxation During Pregnancy	Philip D. Wilson, M.D., Boston
Transplantation of Astragalus and Carpal Navicular Bone	D. B. Phemister, M.D., Chicago William S. Keith, M.D., Chicago
A New Method of Osteotomy for Correction of Long Standing Bony Deformity at the Knee	Armitage Whitman, M.D., New York
A Study of Torsional Deformity of the Lower Extremity with Special Regard to Etiology and Clinical Significance	I. William Nachlas, M.D., Baltimore

Evening

Private Dinners
Reception by President of the American Congress of Physicians

THURSDAY, MAY 11

Morning Session

Nerve Injuries Associated with Fractures	Dean Lewis, M.D., Baltimore
Complicated Contractures of the Hand: Their Treatment by Freeing Fibrosed Tendons and Replacing Destroyed Tendons with Grafts	S. L. Koch, M.D., Chicago
Knee Joint Instability and Crucial Ligament Injury	Arthur Krida, M.D., New York
Fractures of the Condyles of the Humerus	J. S. Speed, M.D., Memphis
Fracture of the Ulna with Dislocation of the Head of the Radius	Samuel R. Cunningham, M.D., Oklahoma City
Treatment of Fracture of the Tibia and Fibula: Kirschner Wire Method	C. F. Eikenbary, M.D., Seattle
Data on Fracture Healing: Series of 2000 Rats	Merrill K. Lindsay, M.D., New Haven

Noon

Executive Session of the Association
Presentation of Certificates to New Members

The organization meeting of the **American Academy of Orthopaedic Surgeons** was held in conjunction with the Clinical Orthopaedic Society in Chicago on January 12, 13, and 14, 1933, Dr. E. W. Ryerson acting as President and Dr. W. C. Campbell as Secretary.

On January 11 preliminary meetings of the Executive Committee were held in which the organization was discussed and committees appointed.

The clinical meetings were held in conjunction with the Clinical Orthopaedic Society and on Thursday, January 12, the following program was given by the American Academy of Orthopaedic Surgeons at the Thorne Memorial Auditorium of the Northwestern University Medical School:

Morning Session

Call to Order	President, E. W. Ryerson, M.D., Chicago
Embryology of Bones and Joints	Prof. L. B. Arey, M.D., Chicago

Bone Pathology	Prof. F. R. Zeit, M.D., Chicago Prof. J. P. Simonds, M.D., Chicago
Symposium on Parathyroidism	M. Ballin, M.D., Detroit P. F. Morse, M.D., Detroit
Address of Welcome	Dean I. S. Cutter, M.D., Chicago
Brief History of Orthopaedic Surgery	Dean I. S. Cutter, M.D., Chicago
Symposium on Neurological Surgery	
Diagnosis of Spinal Cord Tumors	H. W. Woltman, M.D., Rochester, Minn.
Operative Treatment of Spinal Cord Tumors	A. Verbrugghen, M.D., Rochester, Minn.
Diagnosis of Peripheral Nerve Lesions	L. J. Pollock, M.D., Chicago
Peripheral Nerve Surgery	A. W. Adson, M.D., Rochester, Minn.
The So Called Brachial and Sciatic Neuritis	L. J. Pollock, M.D., Chicago
Chordotomy	E. Oldberg, M.D., Evanston
Symposium on Circulatory Disturbances of Extremities	G. DeTakats, M.D., Chicago R. W. McNealy, M.D., Chicago A. W. Adson, M.D., Rochester, Minn. J. T. Case, M.D., Chicago
Living Fascial Suture Methods of Attaching Tendons to Bones	W. E. Gallie, M.D., Toronto
Reports of Committees	

Afternoon Session

Symposium on Arthritis	
Experimental Arthritis	J. A. Key, M.D., St. Louis
Medical Treatment	P. S. Hench, M.D., Rochester, Minn.
Vaccine Treatment	M. Wetherby, M.D., Minneapolis J. A. Freiberg, M.D., Cincinnati
Operations on Sympathetic Nerves	A. W. Adson, M.D., Rochester, Minn.
Arthroplasty	W. C. Campbell, M.D., Memphis
Treatment of Gonorrhoeal Arthritis	H. L. Kretschmer, M.D., Chicago
Symposium on Low Back Pain	
Differential Diagnosis	F. J. Gaenslen, M.D., Milwaukee
Treatment	E. W. Ryerson, M.D., Chicago
Demonstration of Manipulative Treatment	H. H. Cox, M.D., Chicago
Surgery of the Spine	
Fractures	E. W. Ryerson, M.D., Chicago
Spinal Cord Tumors	A. W. Adson, M.D., Rochester, Minn.
Surgery of the Hip	M. S. Henderson, M.D., Rochester, Minn. F. D. Dickson, M.D., Kansas City
Reconstruction Surgery of Upper Extremity	A. Steindler, M.D., Iowa City
Surgery of the Hand	S. L. Koch, M.D., Chicago
Stabilization Operations on the Foot	W. C. Campbell, M.D., Memphis E. W. Ryerson, M.D., Chicago
Treatment of Osteomyelitis	H. W. Orr, M.D., Lincoln, Nebr. S. K. Livingston, M.D., Hines, Ill.
Physical Therapy in Orthopaedic Surgery	J. S. Coulter, M.D., Chicago

Evening Session at Lake Shore Athletic Club

Meeting of the American Academy of Orthopaedic Surgeons	
Dinner	
Moving Pictures Demonstrating the Galeazzi Treatment of Scoliosis	Philip Lewin, M.D., Chicago
The Chicago Century of Progress	E. J. Carey, M.D., Chicago

On Friday and Saturday, January 13 and 14, the Academy participated with the Clinical Orthopaedic Society in their scientific and clinical program.

The officers of the American Academy of Orthopaedic Surgeons elected for the ensuing year are:

President: Willis C. Campbell, M.D., Memphis
Vice-President: Philip D. Wilson, M.D., Boston
Secretary: Philip Lewin, M.D., Chicago
Treasurer: E. B. Mumford, M.D., Indianapolis

Executive Committee:
- F. D. Dickson, M.D., Kansas City
- S. Kleinberg, M.D., New York
- M. S. Henderson, M.D., Rochester, Minn.
- E. W. Ryerson, M.D., Chicago
- John C. Wilson, M.D., Los Angeles
- Philip D. Wilson, M.D., Boston

Membership Committee:
- H. W. Meyerding, M.D., Rochester, Minn.
- E. B. Mumford, M.D., Indianapolis
- Maynard Harding, M.D., San Diego
- George E. Bennett, M.D., Baltimore
- Frank R. Ober, M.D., Boston

It was decided that there should be four types of members,—Fellows, Associate Fellows, Honorary Members, and Corresponding Members.

The second meeting of this Academy will be held in Chicago in January 1934; it will be a three-day meeting,—with three mornings of papers and three afternoons of clinical demonstrations.

At the meeting of the **Chicago Orthopaedic Club** held on February 10, Dr. Kellogg Speed presented a Clinico-Pathological Study of Fracture of Neck of Femur, and Dr. Maurice A. Bernstein led a discussion on Bone Tumors.

At this meeting the following officers were elected for the ensuing year:

President:	Robert Ritter, M.D.
Vice-President:	Jacob Meyers. M.D.
Secretary and Treasurer:	Daniel H. Levinthal, M.D.

The Manual of Surgical Sutures and Ligatures, which has been prepared by Davis & Geck, gives very practical information in regard to the manufacture and use of sutures, as well as of the many kinds of sutures and the choice to be made in the various departments of work. Such information will be of practical aid to the surgeon. The various types of sutures and their preparation are described, with directions and rules for their use, and the information is presented in very concise form, easily available. The booklet will be found to be of definite aid to the medical profession in general, and is distributed free to members of the profession, nurses, and students on application to Davis & Geck, Inc., 221 Duffield Street, Brooklyn, N. Y.

The First Joint Congress of the **Yugoslavian and Czechoslovakian Orthopaedic Societies** met in Zagreb on October 3 and 4, 1932. Prof. Božidar Špišić, President of the Yugoslavian Society, opened the Congress with an address on The Importance of Orthopaedic Surgery in Social Medicine, paying special attention to the subject of the cripple and his position in the social and economic life of the community.

The morning of the first day of the Congress was devoted to the consideration of Tuberculosis of Bones and Joints in its various aspects. The special phases of this subject which were considered were the individual and the social treatment; operation, both as regards time and choice; periarticular arthrodesis, and the indication for surgical treatment; tuberculosis in other organs in cases of bone and joint involvement; choice of employment for tuberculous patients; the need of and results of periodical investigations of the blood composition; results of treatment in hospitals. The large experience which it is possible for surgeons in this community to have with this disease makes such a report particularly valuable.

At the afternoon session the main subject was Rickets, with special reference to the cure of its deformities. The national and social significance of late rickets and of the orthopaedic deformities in those of mature age was discussed by members of both Societies.

The subjects of Scoliosis Deformities as a Sign of Degeneration on the Croatian Coast, Poliomyelitis and the Cure of Paralysis, The Treatment and Classification of the Gastro-Intestinal Symptoms during Poliomyelitis, and Roentgen Therapy for Acute Poliomyelitis were also discussed.

The sessions on the following day were devoted to the presentation of shorter papers and discussion by different members of the two Societies.

The Twenty-Third Congress of the Italian Orthopaedic Society was held in Bologna on October 15, 16, and 17, under the presidency of Prof. Putti. The principal subject for discussion was Congenital Dislocation of the Hip. Prof. Putti pointed out that almost 4000 cases among over 9000 or 10,000 observations were being reported at the Congress, as well as the treatment and observations by the various surgeons.

In his opinion, a population of 42,000,000 might have 84,000 congenital dislocations of the hip, counting two per thousand population. He emphasized the great importance of the knowledge of the very early symptoms and of the hereditary-familial factors. Twenty-two per cent. of his statistics showed an hereditary etiology. He recommended systematic examination of every new-born child.

A very large number of papers were presented by members of the society and by guests from other countries, among whom were Prof. Spitzy of Vienna, Prof. Zaremba of Crakow, and Prof. Max Lange of Munich.

Prof. A. Annevazzi gave a statistical report on The Late Results of the Bloodless Reduction in Congenital Dislocation of the Hip. Out of over 1327 patients operated upon for congenital dislocation of the hip, 1610 hips were treated by the bloodless method. More than 300 of these were examined. The results in the unilateral cases were as follows:

Operated upon under two years of age: good results in eighty-two per cent., satisfactory in nine and six-tenths per cent., bad in two and seven-tenths per cent., reluxation in five and seven-tenths per cent.

Operated upon from two to five years of age: good results in sixty-six and one-tenth per cent., satisfactory in fourteen and one-tenth per cent., bad in eight and seven-tenths per cent., reluxation in eleven and one-tenth per cent.

Operated upon from five to ten years of age: good results in fifteen and nine-tenths per cent., satisfactory in six and one-tenth per cent., bad in thirty-two and nine-tenths per cent., reluxation in forty-five and one-tenth per cent.

Operated upon over ten years of age: good results in sixteen per cent., satisfactory in nine per cent., bad in thirty-six per cent., reluxation in thirty-nine per cent.

The results of the bloodless treatment in bilateral cases of congenital dislocation of the hip were as follows:

Operated upon under two years of age: good results in forty-nine and five-tenths per cent., satisfactory in thirty-eight per cent., bad in five and three-tenths per cent., reluxation in seven and two-tenths per cent.

Operated upon from two to five years of age: good results in thirty-three per cent., satisfactory in thirty-nine and eight-tenths per cent., bad in twelve per cent., reluxation in fifteen and two-tenths per cent.

Operated upon from five to ten years of age: good results in seventeen and nine-tenths per cent., satisfactory in three and six-tenths per cent., bad in thirty-two and one-tenth per cent., reluxation in forty-six and four-tenths per cent.

When the patients were reexamined, the results in the cases of unilateral dislocation of the hip were as follows:

Seen five years or less after operation: good results in seventy-one per cent., satisfactory in nineteen per cent., bad in two per cent., reluxation in eight per cent.

Seen more than five years after operation: good results in sixty-one per cent., satisfactory in eight per cent., bad in fourteen per cent., reluxation in seventeen per cent.

The results in cases of bilateral dislocation of the hip were as follows:

Seen more than five years after operation: good results in thirty-nine per cent., satisfactory in thirty per cent., bad in fourteen per cent., reluxation in seventeen per cent.

It appears from these statistics that while the good results seem fairly permanent, this is not true with the bad results which are considerably increased as time goes on at the expense of the satisfactory results which are at first rather numerous, thirty and twenty-five per cent., gradually diminish to seventeen and eleven per cent. (unilateral and bilateral), and finally drop to as low as five and six-tenths per cent. twelve years after reduction.

The remainder of the session was given over to the separate reports on various interesting orthopaedic subjects.

ROBERT JONES MEMORIAL APPEAL

The death of Sir Robert Jones, of Liverpool, has taken from us one of the most distinguished of English surgeons, the creator of modern orthopaedic surgery, and the founder of the British School of Orthopaedics.

Many of his colleagues, patients, and friends feel that a last tribute should be paid to his memory in recognition of his services to the cause of surgery, and to multitudes of patients, and to recall his service to the Army during the Great War.

Sir Robert Jones was regarded throughout the world as the greatest orthopaedic surgeon of all time; and it is only fitting that his supreme merit should be recognized in this way, and that his example should constantly be brought to mind as an incentive and encouragement to those who come after.

It is hoped to be able to include in our benefactions Liverpool, the Royal College of Surgeons of England, and perhaps other bodies with which he was associated if, as we feel sure will be the case, an adequate sum of money is received in response to this appeal.

Signed by:

Derby, Chancellor of Liverpool University, Secretary of State for War 1916–18, and 1922–24

Arthur Stanley, Chairman, British Red Cross Society, Treasurer, St. Thomas's Hospital

Holburt J. Waring, President, Royal College of Surgeons

Moynihan, Past-President, Royal College of Surgeons, Chairman, Army Medical Advisory Board

E. Farquhar Buzzard, Regius Professor of Medicine, University of Oxford
W. Langdon-Brown, Regius Professor of Physic, University of Cambridge
J. W. Dowden, President, Royal College of Surgeons, Edinburgh
Frank Crawley, President, Royal College of Surgeons, Ireland
Harold B. Fawcus, Director-General, Army Medical Services
Wicklow, President, Central Council for the Care of Cripples
Winifred Portland
A. F. London
Albert Liverpool
H. R. Hurter, President, Liverpool Medical Institution
Alfred Gates, Lord Mayor of Liverpool
Harold Stiles
H. J. W. Hetherington, Vice-Chancellor, Liverpool University
R. E. Kelly, Professor of Surgery, University of Liverpool
Charles J. Macalister
W. I. deC. Wheeler, Past-President, Royal College of Surgeons, Ireland
C. Thurstan Holland
D. P. D. Wilkie, Professor of Surgery, University of Edinburgh
Georgiana Buller, Vice-Chairman, Executive Committee Central Council for the Care of Cripples
A. G. Hunt
W. J. Mayo, Rochester, Minnesota
C. H. Mayo, Rochester, Minnesota
W. E. Gallie, Toronto, Canada
Arthur Steindler, President, American Orthopaedic Association
DeForest P. Willard, Secretary, American Orthopaedic Association
Willis C. Campbell, President, American Academy of Orthopaedic Surgeons
Putti, Bologna
Nové-Josserand, President, International Society of Orthopaedic Surgery

Murk Jansen	Harry Platt
H. A. T. Fairbank	Naughton Dunn
R. E. Elmslie	D. McCrae Aitken
W. Rowley Bristow	S. T. Irwin
G. R. Girdlestone	T. P. McMurray

A. S. Blundell Bankart, President, British Orthopaedic Association

Subscriptions may be sent to Mr. Bankart, 58, Harley Street, London, W.1.

A meeting of Signatories of the Robert Jones Memorial Appeal and others interested in the objects of the Appeal, was held at the House of The Royal Society of Medicine, 1, Wimpole Street, London, W.1, on Thursday, March 9, 1933.

It was decided that all the Signatories should constitute a General Committee for the purposes of the Appeal, and that the following names should be added: Sir Arthur Probyn Jones, Mr. Frederick Watson, Mrs. Kimmins, Dr. E. G. Brackett, Dr. Joel Goldthwait, Dr. R. B. Osgood.

An Appeal Sub-Committee was appointed with power to act and to take such steps as may seem necessary or desirable to raise funds for the Memorial.

It was agreed that the principal object of the national Memorial should be the endowment of Orthopaedic Teaching and Research, but that an endeavor should be made to coordinate local and national interests.

Current Literature

FINAL REPORT OF THE COMMISSION ON MEDICAL EDUCATION. Privately printed from the office of the Director of Study, 630 West 168th Street, New York City, 1932. Also New York City, Columbia University Press. $2.00.

This report, the investigations for which were started in 1925 and have been issued at intervals as separate studies, comprises a consideration of the needs of the public in respect to medical service, the number and distribution of physicians, the ratio of this number to the population and their distribution in urban and rural communities, the social and economic factors to be considered in adjusting medical service to present-day requirements, the progress of the medical sciences, the cost of medical education, and the rôle the sciences play in modern medical training, the prevalence of specialization, the causes for it, and many other factors. In summing up their conclusions the Commission recognizes that it is *the quality of care* that is of greatest importance and not the plan of organizing nor the method of financing. Though it urges standardization of practice on a mass production basis it insists that the unit of practice is the individual patient. It urges that training for the modern physician should include instruction in respect to social and economic conditions.

At present there is a numerical oversupply of physicians, but their distribution is faulty and there is too great a preponderance of specialists. Facilities for transportation, public health services, hospital clinics, home nursing, etc., should furnish a sound basis for providing modern medical care for all classes of the public without resorting to artificial programs.

The Commission recommends a Register of properly qualified specialists, and emphasizes the desirability of a non-specialized practice. They stress as a matter of major importance post-graduate teaching at conveniently located hospital centers where the progress of medical study and practice may be brought home to practitioners too busy to go away to procure it. The training of internes should be so revised that they may be prepared for independent practice in localities where all the facilities to be had during their hospital experience may not be available. Such a high percentage of graduates of "A class" schools pass the State registration authorities that the Commission inclines to the view that graduates of high-grade schools be registered without further examination, the State authorities, through inspection of the schools, being satisfied as to the maintenance of standards. Some of the defects in medical education are due to failures in preliminary training in secondary schools and to the kind of premedical subjects taught, some of which have been impracticable and time-wasting. The Commission would postpone specialized subjects to a post-graduate period and would lay more and more emphasis upon developing a resourceful mental equipment which shall make possible a "continuance education". Correlation of subjects is playing an important part in the scheme of training in the schools of today. The Commission urges the significance of preventive medicine in present-day life and advocates wider familiarity with social problems through a better planned general education.

The Commission believes in a more flexible interpretation of qualifications for medical study, laying emphasis upon character, personality, industry, resourcefulness, ability, and scholarly achievement. The particular method of achieving such of these qualifications as are not native to the individual they are not particularly concerned about. Time should be saved in the preparatory years.

In the medical courses due recognition should be given to changing social conditions and improvements in the techniques of investigation, but the really important influences in training for the profession are the personal contacts of able teachers and practitioners with the student in clinical teaching.

The public should demand a trained leadership in medicine, if it is to protect itself

against incompetency and charlatanism, and should not suffer such leadership to become politically or commercially dominated nor be reduced to mediocrity through mass production methods.

There is included in this report, as an appendix and as part of the basis for the conclusions drawn, a discussion of European methods in medical education, and 159 tables covering the topics discussed in the report.

LE GENOU: ANATOMIE CHIRURGICALE ET RADIOGRAPHIQUE CHIRURGIE OPÉRATOIRE. (The Knee: The Surgical and Roentgenographic Anatomy from the Operative Standpoint.) By Antoine Basset. Paris, Masson et Cie, 1932. 45 francs.

In the beginning, the author emphasizes the necessity of thorough familiarity both with the anatomy and with the roentgenographic appearance of this joint. He recognizes and emphasizes the fact that articulations do not lend themselves kindly to operative procedures, and stresses the necessity for great care in all joint operations. One of the requirements for this care is the thorough knowledge of the anatomy and the methods of procedure.

In the first portion of the book, the author describes in detail the anatomy and the x-ray picture, particularly in its relation to operative procedures, and he also indicates carefully and in detail the significance of the roentgenographic findings. A chapter is devoted to the anatomy of the ligaments and the capsule and the application of the special conformation of these structures to their functions, which has its relation to the operative procedures necessary to them. This portion of the book is copiously illustrated by excellent anatomical line drawings and by roentgenograms, and the significance of the x-ray findings is well described.

In the operative portion of the book, all the recognized avenues of approach to the joint cavity are described and illustrated, and the choice of these methods of approach and the portions of the joint that can be best exposed by them are indicated.

In the surgical portion of the book, the subject of arthrotomies, the different types of fracture involving the knee joint, the lesions of the meniscus, and the lesions of the crucial ligaments are considered in detail. The directions for the operative procedures, both methods and technique, for fractures into the joint are described and illustrated. Also are considered the operations for ankylosis, as well as surgery for tuberculous osteoarthritis, and, finally, disarticulations and intra-articular amputations.

It is valuable to have a work confining itself to the conditions of a single joint, especially one as important as the knee joint. The author has shown throughout the book the results of a careful study of the special structures and functions of this joint, as well as the results of a practical experience in dealing with the clinical problems. The necessity of the great care which has been emphasized in this book in the surgical dealing with joints is particularly valuable and apt in these days of somewhat rash operative tendencies.

DIE CHIRURGIE DER WIRBELSÄULE. (The Surgery of the Spine.) By Dr. Ernst Gold. *Neue Deutsche Chirurgie*, LIV. Edited by Geheimrat Prof. H. Küttner. Stuttgart, Ferdinand Enke, 1933. 45.50 marks.

In view of the interest which has been focused on spine lesions in the past few years, a monograph that includes the newer work is a valuable and timely contribution. Dr. Gold has drawn his clinical material from the rich supply at the University Hospital and other clinics in Vienna, as well as from Prof. Rollier's institution, and Dr. Schrader's clinic in Göttingen. Numerous abstracts and quotations from the literature are representative of the best that has been written on spine conditions. They are frankly labeled as supplements to the experience of Dr. Gold and his coworkers and are effective in removing this monograph from the class of one-man books.

An excellent chapter on traumatic lesions includes injuries of the discs and ligaments as well as fractures. The recent work of Böhler and Schnek occupies considerable space.

Davis is mentioned. The debate over the desirability of reducing compressed vertebral fractures is presented from both sides, with a theoretical endorsement of reduction. There is a good classification of types of spine fractures.

The field of inflammatory diseases is wisely arranged to leave out much dead wood. Only a few words of summary are alloted to the much discussed osteo-arthritis, and space is saved for the careful evaluation of Kümmell's disease, a discussion of fractures with tetanus, and actinomycosis and echinococcus cysts of the spine. Tuberculosis is not overemphasized. Interesting is the typically Austrian condemnation of spine fusion operations in this disease except in a few selected, resistant cases.

Numerous tumors of the spine are presented. Here, as elsewhere in the book, much is lost by poor reproduction of excellent x-ray material. Illustrations of hemangioma, myeloma, and marble bones are good.

Bone lesions of systemic diseases are well represented and there are some excellent examples of congenital abnormalities. The medical man must have a fair background in the field of spine pathology before he can regard this monograph as a primer; but, as a searching study of the unusual, the book is of exceptional value to the orthopaedic and traumatic surgeon.

MEDICAL CARE FOR THE AMERICAN PEOPLE. Final Report of the Committee on the Costs of Medical Care. Chicago, Illinois, The University of Chicago Press. $1.50.

The final report of the Committee on the Cost of Medical Care, issued from the University of Chicago press, represents an attempt to regulate and standardize the practice of medicine, basing such endeavor upon exhaustive surveys of all factors contributing in any way to present-day dissatisfaction over the cost and inadequacy of medical care in certain strata of society. It is in line with other similar standardization attempts which characterize modern civilization, many of which abandon any further discussion as to whether a principle is intrinsically right or wrong, the combatants being carried along by currents of opinion which have caught the popular fancy and appear to be irresistible. The majority report advocates what would amount to taking the practice of medicine out of the hands of the general practitioners, as individuals, to a very large extent, and consigning it to groups, the costs to be met by taxation or insurance or both. The minority report believes the individual general practitioner should continue to be the center of the system with such modernized methods in the conduct of practice as the needs of local communities require and can support.

A factor entering very heavily into the cost of medical care is one to which this report fails to give any consideration,—*viz.*, the disposition, frequently manifested, to subject all patients to the entire gamut of scientific tests where the problem does not justify the procedure. This often means unnecessary hospitalization for the patient and expensive laboratory equipment and technician charges. To avoid the creation of hospital deficits the number of such investigations must be such as to make the service yield a profit. To make service of the sort proposed available for all the people is a tremendously expensive proposition, both in money and ineffectiveness, the cost of which cannot be justified in the results obtained, either to the community or the individual family units. Specialization is overdone and, because it is overdone, so is hospitalization, both of which are costly. If these were curbed effectively, the general practitioner would have less idle time and would be able and willing to dispense his services to a group now hospitalized as "out" or "in-door" patients, to their, and his own, very great advantage, and along with it would come a restoration of the *esprit de corps* of the profession which has been allowed to sadly decline through commercialization. In medicine, as in everything else, the unthinking public has been allowed to believe that because we are in an age of progress, which means that we are in a zone of "trial and error", every new device employed to diagnose or treat disease must be placed at their disposal, either privately or publicly, and of course some one must bear the expense. Unfortunately, the training of the present-day medical student has instilled this idea into the mind of the medical fledgling.

What we need is a survey sufficiently searching to determine what is really worth while and definitely proven, and then only *such* procedures should be released for general use by the profession.

The majority report recognizes the need for reduction in the number of specialists and suggests that a register of those qualified be kept for the benefit of the public. They also urge, as a means of keeping the rural practitioner abreast of the times, an extension service from the medical schools, using suitably equipped local hospitals as the centers for conducting such post-graduate teaching. These two reforms would tend to lessen costs for medical service, divert practice back to the general practitioner where it belongs, and provide the public outside metropolitan centers with the best that medical science has to offer.

HANDBUCH DER GESAMTEN UNFALLHEILKUNDE. II Band. Herausgegeben von Geh. Rat Prof. Dr. Fritz König und Prof. Dr. Georg Magnus, Stuttgart, Ferdinand Enke, 1933.

Volume II of this work is the continuation of the discussion on the relation of industrial injury to disease. Various legal phases of industrial poisoning are elaborated. This is followed by descriptions of the clinical features of chronic poisoning due to inorganic substances, organic substances, and metallic poisons. There is further a discussion of the injurious effects of x-rays in industry.

One chapter is devoted to diseases of muscles, bones, and joints as the results of working with pneumatic apparatus. Under this heading are described and illustrated joint changes of an arthritic nature, necrosis of the carpal lunate, epicondylitis, myositis ossificans, ganglion, and Dupuytren's contracture.

The problem of accident prevention is one which must be overcome by education of the laborer. Under the heading of general principles of treatment there are found numerous references to legal technicalities; indeed the question arises in the reader's mind whether an injured employee is primarily a medical case or a legal case.

It may be said in favor of this work that the subjects are clearly and fully presented, in so far as they portray the relationship between cause and effect of industrial injury. It is, however, to be expected that its usefulness will be limited largely to industrial surgeons of Germany.

THE HISTORY OF DERMATOLOGY. By William Allen Pusey, A.M., M.D., LL.D. Springfield, Illinois, Charles C. Thomas, 1933. $3.00.

The History of Dermatology by William Allen Pusey is an interesting and well written addition to the history of medicine. Dr. Pusey calls attention to the fact that the earliest records, the Edwin Smith Papyrus and the Ebers Papyrus, are devoted largely to skin diseases (which would naturally from their conspicuousness and discomfort be drawn to man's attention) and that the history of dermatology can be separated from the history of general medicine only since the latter part of the eighteenth century. It is interesting to see how many of the skin diseases known today can be recognized in these earliest scientific treatises and how much attention was paid to cosmetics and cosmetic dermatology. The book discusses Graeco-Roman, Arabian, and mediaeval dermatology, dermatology in early modern Europe, the beginnings of modern clinical dermatology in Europe, and, in the last half, modern dermatology in continental Europe, England, and the United States.

Dr. Pusey treats the subject in the first half of the book in broad outline with an intelligent consideration of all the influences which contemporary culture and economic conditions have had on medicine in general,—a part of the book well worth reading by all. The last portion is occupied by a more detailed account of the work of the outstanding figures in modern dermatology, almost too concisely told if the reader is interested in this specialty. It is a pity that Dr. Pusey's own achievements in this field could not be included. The volume itself is attractively made, with excellent illustrations and contains an Historical Index of Dermatology which is of great value to the student.

HYGIENE DES FUSSES. (Hygiene of the Foot.) By Prof. Dr. F. Schede. Leipzig, Georg Thieme, 1933. 1.50 marks.

The author offers this article because hygiene of daily living is neglected, and because such fundamentals commanding medical experience are disregarded. Even the orthopaedist, who should be depended upon for giving counsel to the patient in matters upon physical training, is commonly unmindful of the full needs for development of the body. How foot hygiene may be practised and how ultimately the advice of the physician is sought for foot problems, the weak or relaxed foot, and its relationship to one's general physical and mental status, are discussed.

The foot is the stepchild of the body; this, in spite of the unusual patience it evidences as the weight-bearing organ whose burden is an ever increasing one. Only rarely do we openly show the foot; it is kept covered until a local problem requires attention. When some day it makes itself known, usually in the years of maturity, it is with pain, not unbearable, but almost continuous and boring in character.

Our feet are not intended to be ungainly, or to fail us. As organs of prehension endowed with elasticity, strength, and great mobility, it is surprising to realize what strain they endure. The foot should be as expressive as the hand. Races and tribes living close to nature have no foot troubles. As civilization advances the feet become neglected. From childhood it is put in a shoe, which promptly deprives it of the grasping ability of the toes. We go about on unyielding smooth and hardened floors, which encourages muscular weakness with resultant relaxation. Weakness of musculature manifests itself earlier than any other disturbance of the organs.

Hygiene of the foot is easy to realize but difficult to practise. It is a battle against the conventional methods of living. The foot of a child beginning to walk has no arches. This flat foot is not pathological. The healthy foot of the child needs no heavy, stiff shoe, the strong masculature being sufficient for support. To correct faulty foot posture is not sufficient, the first requirement should be the strengthening of the general musculature. Whether the natural forces are sufficient to sustain the foot properly or whether some mechanical measure is necessary, is purely an orthopaedic problem.

Simple relaxation of the foot, disturbances of the circulation, nodular hardening of the leg musculature, and weakening of the foot articulations, are all factors dependent one upon the other, but they may occur concurrently, especially with the adult. Proper massage to legs and feet are most helpful for restoring muscle tone and circulation to the lower extremities, especially the feet. Such massage should only be undertaken by a physician or under his guidance.

The shoe is a necessary evil, although protection against hard surfaces, cold, wet, and uncleanliness. A useful supportive shoe can be made to measure with the built-in arch; this type is preferred to the inserted arch plates. Since the recommendation of positive rational changes in the manufacture of shoes is futile, only one bit of advice about shoes remains,—relieve the foot of the shoe as much as possible.

In conclusion there are two series of exercises presented for use in the home. The first set-up has to do with the foot alone; the second, with advice for the adult with foot disturbances.

THE MEDICAL SECRETARY. By Minnie Genevieve Morse. New York, The Macmillan Company, 1933. $1.50.

This is a small book of practical suggestions for anyone intending to assume, without previous training or experience, the position of the doctor's secretary or nurse, and is written by one who has evidently had a very considerable practical experience. Such a position demands attention to many details of varied character, the necessity of which would escape the appreciation of a novice, even though trained to some allied occupation. The duties and routine in a doctor's office are usually the gradual outgrowth of a man's methods and individuality and only experience can give the necessary training and adaptation for the particular position. A quick intuition and common sense are two qualities most helpful and are not found in general too highly developed. This book will

supply a great deal of that information which ordinarily can be acquired only by more or less practical experience. The abbreviations and usual medical terms, which are a new language to the uninitiated, and which are well explained, help the inexperienced beginner who, as well as the more experienced individual, will avail herself of frequent recourse to this book for information.

A Standard Classified Nomenclature of Disease. New York, The Commonwealth Fund Division of Publications, 1933. $3.50.

As the result of three years of intensive work, the National Conference on Nomenclature of Disease has issued A Standard Classified Nomenclature of Disease, edited by the Executive Secretary, Dr. H. B. Logie. The confusion and inaccuracy which has resulted from the lack of uniformity of record has been prolific of misunderstanding and of the obstacles to cooperation. The Conference represents every branch of medicine and surgery, health departments and agencies engrossed in the medical and surgical health problems, and has covered the entire ground. This work has established a uniformity in the whole field of medicine and represents a very marked aid in the work of establishing medicine and surgery on a more scientific basis.

Dr. Leo Mayer of New York was the chairman of the committee which had charge of the orthopaedic section. He is particularly qualified for this task and has devoted a great deal of his time to its accomplishment.

Die Todesfälle und Amputationen des Unfallkrankenhauses und der Arbeiter-Unfallversicherungsanstalt für Wien, Niederösterreich und Burgenland in den Jahren 1926–1930 unter besonderer Berücksichtigung der Sepsis Nach Frischen Offenen Verletzungen. (Deaths and Amputations Resulting from Sepsis at the Accident Hospitals of Vienna, 1926 to 1930, inclusive.) By Dr. Walther Ehalt. Berlin, Julius Springer, 1932. 4.20 marks. (Beihefte zur Monatsschrift für Unfallheilkunde und Versicherungsmedizin. Heft 14.)

The intention of this comprehensive report is brought out in its finality. It sums itself up in a discourse from which there is developed the fact that sepsis may be prevented. There is a detailed consideration of the deaths and amputations at the Accident Hospital and the Workingman's Accident Insurance Hospital, of Vienna, for the five-year period 1926 to 1930.

In concluding the subject "Causes of Death" it is brought to forceful attention that many of the injuries were of minor type, wherein sepsis developed because of an error in treatment. Many patients developing this complication continued in their occupation and failed to receive proper hospital care until the condition from their injuries had advanced too far. Hence, the purpose for emphasizing the policy that regardless of the apparent trivial nature of any wound it must be considered as an injury requiring most careful surgical consideration.

In making a study of the deaths it is observed that the cases treated outside of the hospitals resulted in the development of a greater percentage of gas gangrene, sepsis, and tetanus, than those hospitalized. A great many of the deaths from sepsis had developed from only a minor injury. In all of the deaths at the hospitals from sepsis it was possible to learn that some error in treatment previous to admission was the cause.

The Relationship of Calcium Metabolism to Diseases of Bone. David P. Barr. *Am. J. Cancer*, XVI, 1424, Nov. 1932.

The author has assembled available data on the changes in calcium metabolism present in certain radiologically recognizable diseases of bone. Generalized decalcification may be due to deficient diet, hyperactivity of the parathyroid glands, disuse, or thyrotoxicosis. These conditions may show approximately normal values for calcium and phosphorus in the serum in spite of a negative calcium balance.

Osteitis fibrosa cystica presents high serum calcium values, while the phosphorous may be much diminished. Calcium excretion in the urine is high, resulting in a negative

balance. These changes are the result of the underlying hyperparathyroidism. Solitary bone cyst on the other hand shows no abnormality of calcium metabolism. The hyperactivity of the parathyroids in cases of multiple myeloma and generalized carcinamatosis appears to be secondary to the processes in the bones.

Further studies are necessary to establish the rôle of calcium metabolism in the diseases characterized by excessive calcification,—namely, Paget's disease, pulmonary osteo-arthropathy, and the osteosclerosis of Albers-Schönberg.

In discussion of this paper, J. D. Camp drew attention to two characteristic roentgenographic findings in cases of osteitis fibrosa cystica,—namely, miliary granular changes in the calvarium, and small subperiosteal areas of cortical absorption especially in the long bones.

The paper is illustrated with roentgenograms characteristic of the various conditions described.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

METASTATIC MALIGNANT LESIONS IN BONE. Charles G. Sutherland, Fred H. Decker, and Earl I. L. Cilley. *Am. J. Cancer*, XVI, 1457, Nov. 1932.

The authors have analyzed the experience of the Mayo Clinic with metastatic malignant lesions in bone, comprising 1032 cases with involvement of 1569 regions. They summarize the evidence for dissemination by lymphatics and by blood stream and conclude that both types of spread are implicated in bone metastases. Metastases occur most frequently where red bone marrow persists, and they may be osteoclastic or osteoplastic. The nature of the metastatic process is dependent on the seat of the primary tumor, its degree of malignancy, and its rate of growth. Tables are given showing the age distribution of the cases involved, as well as the situation of the bone metastases in relation to the site of the primary lesion. The breast and prostate were the commonest sites of origin, accounting for over half the total cases, and for over two-thirds of the total lesions involved.

Carcinoma of the Breast—Bone metastasis probably takes place in over fifty per cent. of cases of cancer of the breast. The lesion is almost invariably osteoclastic. The metastases were commonest in the pelvis, although the lumbar spine and ribs also showed a high incidence.

Carcinoma of the Prostate—Estimates of the incidence of bone metastasis in cases of carcinoma of the prostate range from thirty to seventy per cent. Here again the pelvis accounts for more than half of the metastases of prostatic carcinoma, although the lumbar spine, femora, and ribs also show frequent involvement. These metastases are predominantly osteoplastic.

Tumors of the Kidney—Hypernephroma presents metastasis to the bone in about five per cent. of cases. Fifty-one cases are included in this series, with involvement of seventy-four regions. The metastases are osteoclastic, tend to be fewer in number, and cause marked local destruction, often complicated by pathological fracture. Although pelvis and spine show involvement most often, numerous other regions are frequently implicated.

The authors continue their analysis with discussion of the other types of primary carcinoma, less frequently involving bone metastases, such as uterus and ovary, stomach and intestines, thyroid, bladder, etc. Of interest are several bone metastases from epithelioma of the skin, especially of the extremities. It is also interesting that although there are a few cases deriving from the tonsil, larynx and pharynx, there are essentially none derived from the buccal mucosa, lip, or accessory sinuses.

The article concludes with a satisfactory discussion of the differential diagnosis of the lesions.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

A STUDY OF THE HIP JOINT FROM THE STANDPOINT OF THE ROENTGENOLOGIST. L. B. Morrison. *Amer. J. Roentgenology*, XXVIII, 484, Oct. 1932.

This is a comprehensive review and x-ray study of the hip joint which includes the acetabulum, the anterior inferior spine of the ilium, the articular head of the femur, the

neck and the major and minor trochanters, because certain lesions arising in relation to these are significant.

The characteristics of the adult hip are reviewed as well as the theories of congenital hip dislocations. The author points out that the acetabular defect must be attributed to failure of the secondary genetic center to develop. Therefore, we should not infer that the acetabulum deepens to any extent when once a hip has been reduced. Acetabular development will depend upon the potential power of growth retained in the genetic center. Pressure of the head (reduced) may indirectly stimulate this center.

The early congenital hip can be diagnosed by the following changes,—long and shallow sockets, the portion of the acetabulum above the epiphysis is slightly elongated and more shallow, the femoral head lies above the level of the Y cartilage.

The author concludes that the accessory acetabular rim epiphysis, with its genetic center, is the foundation upon which our knowledge of congenital hip and other anomalies of the hip should be based.—*J. Kulowski, M.D., Iowa City, Iowa.*

NOTE.—This article was one to which Dr. Morrison had given a great deal of time and study. Unfortunately, it was his last contribution to the medical literature because of his untimely death on January 16, 1933.—*Editor.*

RECONSTRUCTION-ARTHROPLASTY OPERATION FOR THE HIP. Samuel Kleinberg. *Am. J. Surg.*, XVIII, 64, 1932.

The author describes an operation for reconstruction of the hip which is well conceived, practical, and a distinct advance in the treatment of the type of hip for which the ordinary reconstruction operation has been done.

The operation consists of an osteotomy in the vicinity of the joint line and dislocation of the upper extremity of the femur which was then remodeled into a head and neck, the acetabulum having been cleaned out and enlarged by a reamer. Arthroplasty is then done after the manner of Campbell.

The advantages claimed for the operation are:

1. The pain is reduced to a minimum because of the smoothness of the new head and the covering with a double layer of fascia.
2. The use of the fascia assures a fairly extensive range of motion in the hip joint and the stability of the hip postoperatively is satisfactory.

Seven case reports with x-rays are included. These consist of three cases of ununited fracture of the hip, two cases of hypertrophic osteo-arthritis of the hip, and two cases of ankylosis of the hip. Further cases and later end results would be valuable and interesting.—*Custis Lee Hall, M.D., Washington, D. C.*

END-TO-END APPROXIMATION AND ACCURATE REDUCTION AS A NECESSITY IN FRACTURE THERAPY. Walter W. Ebeling. *Am. J. Surg.*, XVIII, 272, 1932.

The author discusses several interesting points which are worth considering, including the aims in fracture therapy, method of attaining accurate reduction, and a timely discussion of the satisfaction of the patient; also the criteria for sufficient reduction and the exceptions which may be met with, especially in the younger, and the necessity for accurate reduction, especially when the fracture is near or adjacent to a joint.

The author also emphasized the fact that the operating room is the place for the care of fractures, stresses the rigid asepsis, and approves of the Lane-plate technique.

The difficulty of the standardization and treatment of fractures is also discussed and the individualization of each fracture from the standpoint of the patient and his occupation, the age of the patient, the procedure indicated in reduction, type of fixation, the importance of after-treatment, and the consideration of the surgeon as an individual.—*Custis Lee Hall, M.D., Washington, D. C.*

OPERATIVE TREATMENT OF PARALYTIC GENU RECURVATUM. Willis C. Campbell and Joseph I. Mitchell. *Ann. Surg.*, XCVI, 1055, 1932.

The operation was first described by Campbell in 1918.

The lower third of the patella is fixed in the anterior head of the tibia, the upper two thirds being left free to articulate with the femoral condyles, forming a stop-joint and preventing hyperextension of the knee.

Through a linear incision over the patella the quadriceps tendon is divided by a Z-shaped incision, the capsule of the knee joint on either side of the patella is incised, and the patella retracted downward. A portion of the infrapatellar fat pad and the articular cartilage of the patella are excised from its lower third and the patellar tendon and periosteum are stripped from its anterior surface. A cavity is made on the upper anterior aspect of the tibia by an osteotome. The denuded patella is inserted and secured by suture.

The wound is closed and the knee fixed at 160 degrees' flexion in a cast, to be worn for eight weeks, when a stop-lock brace is substituted. This operative procedure has been modified by Mitchell so that the quadriceps tendon is not disturbed.

Complete extension or even slight hyperextension is essential in paralyzed limbs to allow the knee to "lock"; it will be unstable and will flex when weight is borne.

Seven cases are reported; the operative procedure and the cases are well illustrated.—*N. T. Kirk, M.D., Major, Army Medical Corps.*

SUL TRATTAMENTO DEL PIEDE TALO PARALITICO (Treatment of Paralytic Pes Talus). O. Pellegrini. *Arch. di Ortop.*, XLVIII, 595, 1932.

Pellegrini observed that the pes talus cannot be corrected by tendon transplants of multiple muscles or the triceps sural. This method does not assure, other than the correction of the attitude of dorsal flexion, an active plantar flexion and much less the realization of a stable attitude of equinus of the foot which is necessary to compensate for the shortening of the limb and stabilizing the leg. The association of a tibioastragaloid arthrodesis with muscle transplants overcomes the above deficiencies without any immediate or remote inconveniences.—*Peter A. Rosi, M.D., Chicago, Illinois.*

CALCAREOUS DEPOSITS IN THE SUPRASPINATUS TENDON. R. C. Elmslie. *British J. Surg.*, XX, 190, Oct., 1932.

Reference is made to the previous publications of Codman, Painter, and Brickner on this subject. Eight cases are reported, in seven of which operation has been done. The x-ray appearance was very characteristic in seven of the cases. Operation seemed justifiable because of the very severe pain, particularly in the acute cases. All the patients were relieved by operation, but several of them were very slow to gain full function of the shoulder. The usual findings at operation were an area of inflammatory tissue over the greater tuberosity of the humerus. It was usually a yellowish mass containing material like that in a dermoid cyst and in several instances the yellow material continued into a cavity in the greater tuberosity. In each case the cavity was curetted. In some cases it was adherent to the supraspinatus tendon and it was necessary to excise a piece of the tendon.

Pathological examination showed non-crystalline calcareous matter mixed with giant cells and inflammatory cells surrounded by fibrous tissue in various stages of development. Chemical examination showed the deposit to be calcium stearate in one case and, in another, both calcium phosphate and calcium carbonate.

The writer believes that these deposits are laid down following a tear of the muscle insertion with the usual soft-tissue damage, that the inflammatory tissue becomes calcified, and that the calcareous matter then acts like a foreign body. No x-rays are shown following operation to show that all the calcareous tissue was removed and that it had not reappeared.

MALIGNANT GIANT-CELL TUMOUR OF BONE. E. S. J. King. *British J. Surg.*, XX, 269, 1932.

A man of fifty-six with a tumor of the lower end of the radius of four years' duration was thought to have a benign giant-cell tumor and was treated by deep x-ray. He did not improve and operation was done five months later. Pathological examination showed what was thought to be a benign giant-cell tumor. He later developed a recurrence and amputation was done. A diagnosis of malignancy was made and the former specimen was carefully studied. Many areas did show a benign condition, but others showed malignancy. The patient died of metastases to the lungs and spine, but there was no autopsy.

No roentgenograms taken before x-ray treatment was given are shown.

AN AMBULATORY DISTRACTION SPLINT FOR LEG FRACTURES. E. Robert. *British Med. J.*, II, 1051, 1932.

Robert describes an ambulatory method of treating fractures of the tibia. In principle, the apparatus consists of two transfixion pins similar to Steinmann's one. One of these is hammered through each fragment. The projecting ends of each pin are then grasped by a pair of distractors, one on each side of the leg. A bolt with right and left hand threads working in sleeves, enables the ends of each distractor to be separated and strong skeletal traction to be applied to the fragments. By this means the fragments are adjusted into perfect position. The two distractors are then clamped into a fixed relationship to one another by an adjustable bridge. The patients walk after the second day. These cases have been so treated with good results.—*R. I. Harris, M.B., Toronto, Canada.*

THE TREATMENT OF THE PARALYSES OF POLIOMYELITIS. Jean Macnamara. *Canadian Public Health J.*, XXIII, 517, Nov., 1932.

Part I. Under "General Principles" Dr. Macnamara discusses the importance of proper care of poliomyelitis cases from an orthopaedic standpoint. She states that the survivor of an attack of paralysis has an expectation of life as long as a person not so affected, if the respiratory and abdominal muscles escape or recover. She points out the many possibilities of starting deformities while the patient is still confined to bed, and states that such deformities are "in every instance preventable".

In ambulatory cases Dr. Macnamara speaks of the great benefit derived from keeping the affected limb warm. She has found that, when special attention is paid to this, bone atrophy is less. She is doubtful about the benefits to be derived from pool treatments, except in cases with all good to normal muscles, feeling that more damage is done to weakened muscles by going without apparatus.

Part II. "Some Details of the Management of Early Cases." This part is taken up almost entirely with a detailed description of apparatus that can be made by any one for bed patients. Saline baths and heliotherapy are described and their respective benefits noted.

Part III. "Some Organizations to Provide This Care." Dr. Macnamara lists some of the organizations in this country and abroad and describes their methods of follow-up care.

FRACTURE OF THE ANTERIOR SUPERIOR SPINE OF THE ILIUM. Frederick Christopher. *J. Am. Med. Assn.*, C, 113, 1933.

The author reviews the literature of this fracture and presents a case coming under his care in which it had occurred. The treatment given this patient was of a conservative nature,—merely rest with the hip in the flexed position for a time, followed by gradual resumption of activity. Other reports on this condition as given by the author show that by conservative treatment the period of disability is only about one month, while by operative reattachment of the broken process the period of disability is longer. In either case the end result is perfect.—*H. E. Hipps, M.D., Dallas, Texas.*

Reduction of Dislocated Shoulder: A New Method. J. W. Shumate. *J. Am. Med. Assn.*, XCIX, 2181, 1932.

The method as presented by the author consists of traction on the abducted humerus by a bandage over the operator's shoulder and hooked over the semiflexed arm of the patient. Traction is obtained by the operator leaning backward and at the same time pushing against the patient's chest with his hands. His hands on the patient's chest are in such a position that the thumbs palpate the head of the humerus and as traction draws the head out from the subcoracoid space it is pushed into the glenoid fossa.—*W. B. Correll, M.D., Dallas, Texas.*

Recherches Histologiques sur L'Innervation des Articulations des Corps Vertébraux. Adolphe Jung and Alexander Brunschwig. *Presse Méd.*, XL, Pt. 1, 316, 1932.

This interesting anatomical study, which emanates from the clinic of Leriche of Strassbourg, is a valuable addition to the voluminous and important contributions which Schmorl published, but whose work is not referred to.

The authors show that sensory nerves are numerous in the anterior common spinal ligament, while of much lessened incidence in the posterior common ligament. Also that the nerve trunks are myelin-free. The intervertebral disc itself contains no nerve tissue whatever.—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

Le Traitement des Fractures du Col du Fémur. L. Tavernier. *Presse Méd.*, XL, Pt. 1, 604, 1932.

The article deals with fresh fractures of the femoral neck. After reduction (traction and lateral pull) a screw is inserted through the great trochanter into the head of the femur. Control at various stages by means of successive roentgenograms.

Since no cases are reported, there is little to interest Americans who for many years have tried this and similar methods.—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

L'État Actuel de la Question du Bactériophage. A. Seldeslachts. *Rev. Belge des Sciences Méd.*, IV, 296, 1932.

This is an excellent exposition of the history as well as the actual status of the subject of bacteriophage. The article does not lend itself to the process of abbreviation, but it ought to be translated into English. There is a fairly large bibliography, but America is poorly represented in it.—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

Surgery of the Ankylosed Joint. Willis C. Campbell. *Surg. Gynec. Obstet.*, LV, 747, 1932.

This contribution to our knowledge of the ankylosed joint is based on the records of 325 arthoplasties. It is packed full of wisdom drawn from this large experience and should be read carefully by all who contemplate the mobilization of ankylosed joints. Maximum success is predicated on the close observance of many important factors. These are listed under sixteen headings which include etiology, duration, distribution, position of ankylosis, shortening, abnormal osseus structure eburnation, osteoporosis, age, and social status and occupation.

X-ray examination before and after arthroplasty is discussed.

The operative technique is divided into three parts: (1) the plastic adjustment of the soft parts; (2) the reconstruction of bone; and (3) the interposition of tissue. Each step is described and the after-treatment is outlined.

"Unless a joint can be restored in which there is approximately normal endurance, a stiff joint in a good position is more serviceable."

At operation a minimum impairment of surrounding soft-tissue circulation is stressed, the nutrition of the bone ends being a large factor in the later functioning of the reconstructed joint.—*Richard McGovney, M.D., Los Angeles, California.*